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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

NOVEMBER 1, 1988

REDISCOVERING AMERICA

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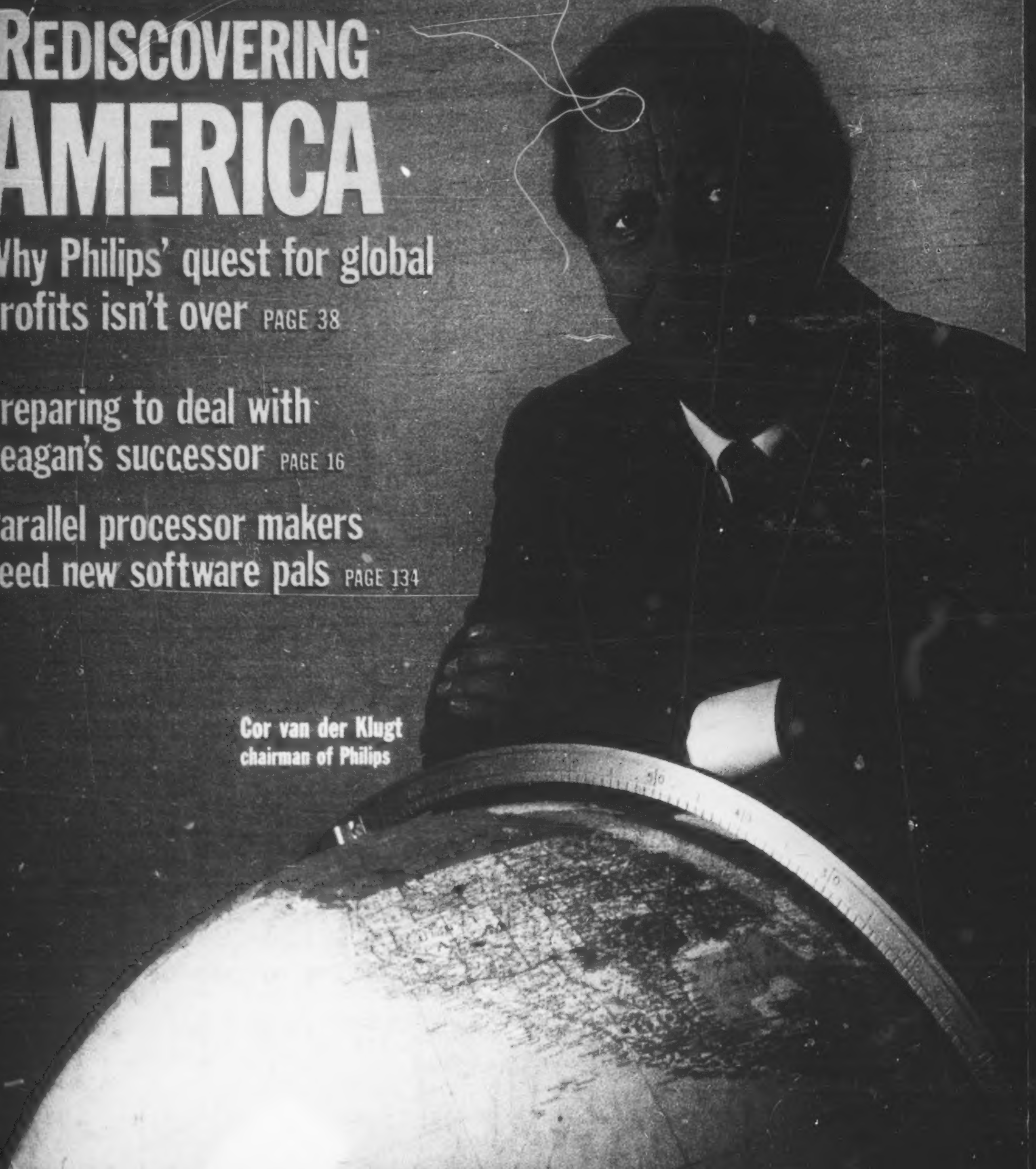
Preparing to deal with Reagan's successor PAGE 16

Parallel processor makers need new software pals PAGE 134



Cor van der Klugt
chairman of Philips

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE
VOL. 14, NO. 21
November 1, 1988

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Dutch colonial

Perhaps the Dutch settlers should never have sold Manhattan. That's what Cor van der Klugt, chairman of the giant Philips electronics empire, recently told contributing editor Jack Gee.

Van der Klugt was being flippant, of course — using the historical reference to platform a plea for free trade. The Dutch, after all, were perhaps the most mercantile of all nations three and four centuries ago.

But perhaps the Philips chief is right. Had the Dutch held onto New Amsterdam, as The Big Apple was then known, perhaps his $25 billion corporation would have cut a better profile — and better profits — in U.S. electronics markets. As van der Klugt freely admits in our cover story, Philips has to . . . rediscover America: "Unless we have strength in the U.S., we will not be able to compete globally," he concedes.

In a lengthy and exclusive interview, van der Klugt discusses everything from Philips' restructuring plans to the need for standards in the CD-ROM storage technology pioneered by the Dutch electronics colossus. We're sure that anyone with a global perspective of this industry will find van der Klugt's views fascinating.

Parallel software, please

The buzzwords are going mainstream: we're hearing terms like "fine-grained" and "massively parallel" more and more. That's the language of the parallel-processor world. But as senior editor Anne Knowles explains in her thoughtful story on the parallel-processor market, there's another language that makers of multiprocessor computers need to learn: the language of software that will run on any of their speedy machines.

Anne Knowles, senior editor

After Reagan

With presidential election day just a week away, the media is riveted to every sneeze the candidates make. And we're hard-pressed to find any electronics executives who have any intentions of backing Dukakis — except for Sun Microsystems' cofounder Bill Joy, that is. Regardless of who gets the vote, though, the electronics industry has to prepare for a change of the White House guard. We asked Washington-based contributing editor Marty Chase to watch how the lobbyists are changing tactics to ensure that the U.S. electronics voice is heard as loudly as before.

JOHN KERR, managing editor

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BPA ABP

Why new telecom talk has National and AMD tingling

There's promise of a $2 billion plus market for chips when users adopt ISDN in earnest. But that's at least five years off

It's not a household word yet, but the Integrated Services Digital Network (ISDN), a new telecommunications standard for sending voice *and* data down existing phone lines, is already taking the telecom industry by storm.

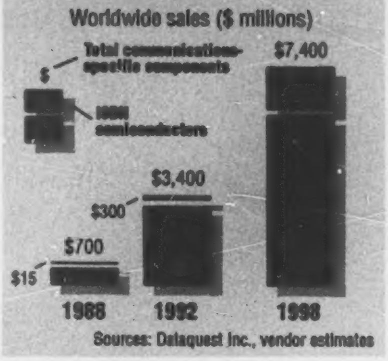
With the advent of ISDN comes a potentially huge market for semiconductor vendors, eager to exploit this practically virgin telecommunications territory. From PC boards replacing soon to be obsolete modems, to central office switching equipment and handsets, the opportunities for semiconductor vendors seem endless.

That's why at least 20 major chip makers, including Fujitsu Ltd., Intel Corp., Motorola Inc., National Semiconductor Corp., SGS-Thomson and Siemens AG, have announced their intentions to enter the fray, and several are now shipping products.

But don't think this is a big market yet. Although European nations are further along with pilot ISDN installations than the United States, optimistic market estimates put worldwide ISDN chip sales for 1988 at a scant $15 million. That compares with a total communications-specific components market of about $700 million, according to market researcher Dataquest Inc. Wags point out that ISDN also stands for "I Still Don't Know."

The biggest cloud on the horizon concerns when ISDN will penetrate its first target market: businesses. It is now in field trials in 19 cities in the United States, according to Dataquest analyst Roger Steciak, and he says the standards —now being debated by a number of worldwide committees — are mostly set. But fewer than 100,000 ISDN lines have been installed nationwide, according to Fujitsu America Inc. estimates, so not many ISDN handsets and terminals are up and running —and obviously not many chips are being sold. Even the pro-ISDN market watchers agree that no one is going to make any money for at least five years.

ISDN chip sales growth



Sources: Dataquest Inc., vendor estimates

ISDN chips could make up over a quarter of all communications-component business in 10 years

But ISDN demand should begin to stir semiconductor sales after that. By 1992, claims Dataquest, the annual worldwide market for ISDN chips could be worth $300 million. But the real growth spurt may not be until the late 1990s, when Dataquest estimates ISDN component sales could top $2 billion — perhaps over a quarter of the total communications-specific components market.

Given that, "the question is how much to invest and how long to invest," AT&T's communication devices product manager Lynn Ditty notes. "ISDN has been slow to take off. The standards have taken a while to agree to."

Ma Bell's merchant move

AT&T has made a "sizable investment in the market," although some critics question whether its merchant ISDN push is really important to the vertically oriented communications giant. Ditty acknowledges that internal need for chips is "high, but it is important that we have a presence in the merchant market. We want to see ISDN succeed as a standard."

What's keeping other big chip companies heavily involved in the market are some signs of end-user interest and acceptance of ISDN. ISDN equipment maker Fujitsu has noticed an optimistic change in buying patterns over the last year. "We aren't pushing the market anymore," says communications product manager Dean Wolf. "We are really feeling the pull." ISDN handsets and terminals and PC add-in boards are the big sellers now, he says.

With ISDN acceptance leading in Europe — particularly in West Germany, where an upgrading of digital switches should be available to 85,000 users by 1990 — it's not surprising that major U.S. chip vendors are joining hands with their European counterparts. National, partnered by SGS-Thomson, keeps corporate interest high by talking to end users in MIS departments of *Fortune* 500 companies. The company is also unabashedly ambitious: "We have made a significant investment in time, people and money," says communications product manager Gary Johnson. "We have invested heavily for leadership. We are not in it for second or third place."

Advanced Micro Devices Inc. is equally eager: through its partnership with Siemens, it claims that the duo has the edge, since it has been in development with ISDN since 1981, with something like 100 to 150 man years invested.

But for small companies, the strategies must be different, as big profits in five years will not pay the bills now.

Cirrus Logic Inc., for example, has developed a high performance part for the computer arena that "can be extended to include high-performance processing of ISDN," says president Michael Hackworth. "It's irresponsible to risk investors' money by depending on ISDN revenues in the short term," he says.

And start-up Level One Communications Inc. plans to be set whichever way the market goes, according to technology vice president Francois Creppin. Creppin says the company is now selling into the pre-ISDN market and can sell both ISDN and pseudo-ISDN parts in the future. If ISDN doesn't evolve as planned, the company "will continue to be a major supplier in the voice/data arena," he says.

VALERIE RICE

Building a better mouse market

Microsoft leads the pack, with plans to ship 1.5 million mice this year — half of the total 3 million high-tech critters sold

When Webster's published the latest edition of its *Collegiate Dictionary*, it added a new meaning for the word "mouse." In addition to being a small rodent, a timid person and a dark-colored swelling caused by a blow, a "mouse" was recognized as "a small, mobile manual device that controls movement of the cursor on a computer display." Indeed, the continuing explosion in demand for this new breed of mice has made this definition of mouse a household word.

Apple Computer Inc. popularized the non-rodent variety, making them standard on the Macintosh models. But in the PC world, mice are only now starting to have a major impact. Until the relatively recent advent of desktop publishing and operating systems that make use of pointing devices, the major stumbling block to sales in the PC arena was the fact that only about 250 to 300 of the more than 20,000 major MS/DOS applications programs actually needed a mouse.

Old-time PC users and developers alike denigrated mice, with Seymour Rubenstein, developer of WordStar, the first major PC-based word-processing program, once saying that mice would become popular when people grew a third hand. They were wrong.

Today, many programs, including Microsoft Corp.'s Excel spreadsheet and the DOS 4 and OS/2 operating systems, rely on mice for added speed and convenience, and Dataquest, a San Jose-based research firm, predicts that 50% of all computers will have alternative pointing devices by 1991, compared with today's 10% installed base.

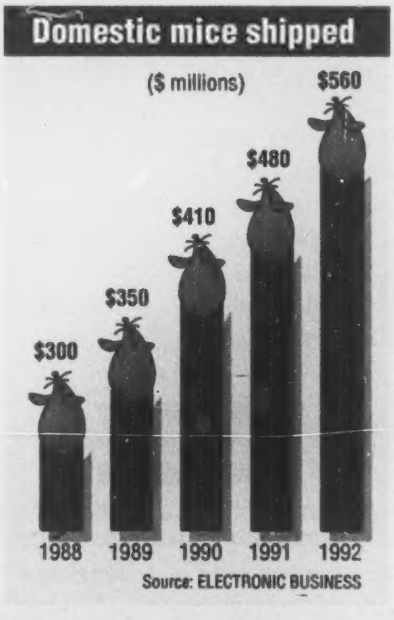
Mice are proliferating. More than 3 million units will be sold by the end of this year. And Dataquest predicts demand will grow 17% a year in the near-term. Dataquest is confident that with an expected average 60% annual increase in CAD software sales between 1987 and 1990, and a 23% annual increase in the business graphics market, mice will be popular long before people grow a third hand.

The Big Three

According to Fremont, California-based MSC Technologies Inc., nearly two dozen companies are breeding mice. Microsoft, MSC, and Logitech Corp. are the market leaders, with the three competitors all selling through distributor, retail, and OEM channels. With 1.5 million mice expected to be shipped this year, Microsoft accounts for half the mouse market. Increasing competition will ultimately decrease Microsoft's market share, according to Michael Goulde, director of the Norwell, Massachusetts-based CAP International Corp. Information Systems Division, but the market leader will continue to increase sales volume as the market expands.

Microsoft's initial 1983 marketing push was designed merely as an introduction to the use of mice on PCs.

Domestic mice shipped



Source: ELECTRONIC BUSINESS

"We took an evangelistic role at the beginning," says Rich Able, Microsoft's group product manager for hardware. But now the Redmond, Wash., firm is focusing on improving awareness of its own upscale mouse. Microsoft's current marketing strategy, according to Abel, is to "position our mouse as a premium product and bundle it with various applications programs, such as Windows or Microsoft Paintbrush [a graphics program]."

Mice were originally developed at the Xerox Palo Alto Research Center. Conventional mechanical mice, such as those produced by the Japanese Alps Electric company and sold under the Microsoft and IBM labels, operate on any flat horizontal surface, relying on friction to activate small mechanical sensors.

With sales of over 500,000 units, MSC Technologies emphasizes the technological advantage of their PC Mouse, whose high resolution (up to 2,000 dots per inch versus 300 dpi for most mechanical mice) optical mouse, has no moving parts.

Another innovative mouse is the Manager Mouse from The Torrington Co. of Torrington, Conn. The $229 mouse without a tail can operate up to four feet away from its infrared sensor. Niche companies like Torrington rely on technical innovation in their marketing battle with the giant Microsoft.

The Macintosh is the other major user of mice, with a 100% penetration, but that computer comes with the Apple mouse, greatly reducing the third-party market.

Choices

Most mice are of the two- or three-button variety, offering, respectively, three- and seven-key combinations. IBM and Microsoft sell two-button mice, while most others use three buttons. The three-button mouse, considered confusing to many users, is mostly intended for those needing the extra keys for CAD or desktop publishing.

Although every mouse manufacturer touts its technology as the best, experts say all mice seem to work about equally well. However, important factors in choosing a mouse are: how they feel in the hand, number of buttons, compatibility and resolution.

JOHN McCORMICK

Since 1985, Amdahl has bested IBM at its own mainframe game. But IBM's ESA operating system and planned "Summit" architecture may soon change that

Can Amdahl always follow Big Blue's zig-zags?

BY ANNE KNOWLES

Is E. Joseph Zemke, president of Amdahl Corp., intimidated by IBM?

You bet he is. "IBM's a $60 billion company, and if they wanted to start a bloody price war, they could bring the U.S. government to its knees," says the 46-year-old executive who competes with Big Blue in the $15 billion mainframe computer market.

That's fear and loathing on IBM's trail. As the leading plug compatible mainframe (PCM) manufacturer, Amdahl, which recorded revenue of $1.5 billion in 1987, lives in Big Blue's shadow, vulnerable to its every whim, and dependent upon its every move. E. Ted Springstead, Amdahl's senior vice president, marketing operations, puts it another way: "When IBM zigs, we zig."

But that is the nature of its business. The Sunnyvale, Calif., manufacturer, in which Fujitsu Ltd. holds a 44% stake, has been playing catch-up with IBM ever since it began selling IBM-compatible mainframes 13 years ago. Amdahl has had its ups and downs in that time (see chart), but in the past two years it has hit its stride. And for the first time in the PCM market's history, Amdahl has turned the tables on IBM, forcing Big Blue to play catch-up, too.

Amdahl has established itself as a credible alternative to IBM in what is IBM's most lucrative market. It has done so using tactics that any electronics manufacturer can understand: a commitment to quality that comes from the top office, coupled with fiscal conservatism and a marketing stance that exploits attractive add-ons to differentiate Amdahl's computers from IBM's. The PCM maker has also achieved these goals with leverage that not many companies in the United States can enjoy: a majority equity stake plus engineering support from a Japanese electronics giant.

The specifics of Amdahl's achievements are intriguing. For example, the company announced its new family of mainframes before IBM did. Amdahl, which by necessity must outperform and underprice IBM's systems, usually allows IBM to go first so it can be sure to maintain its price/performance edge. But in May, Amdahl unveiled its 5990 series a full two months before IBM announced its comparable 3090 S series of systems. And when IBM's systems came out priced very aggressively, Amdahl quickly responded. Less than a week later, the company announced price reductions of up to 17% on its machines.

That priced its top-of-the-line 5990-1400 at $11.3 million, 10% lower than IBM's 3090 600S, and decreased its cost per MIPS (millions of instructions per second) to a record low of $99,000. "With these changes," says John C. Lewis, Amdahl's chief executive officer and chairman of the board, "our 5990-1400 processor continues to be the price/performance leader, in addition to being what we believe is the most powerful computing system available in the System/370-compatible marketplace."

Amdahl has also cracked some of IBM's bread-and-butter accounts. In two years, the company has doubled its number of *Fortune* 500 accounts,

Christopher Springmann

Healthy respect for Big Blue from Amdahl president Joseph Zemke: "IBM could bring the U.S. government to its knees"

from 12 at the end of 1985 to 26 at the end of 1987. And in the first half of this year, says Zemke, Amdahl increased its installations at new customers and new sites of existing customers by 44%.

Also, in 1987 the PCM maker broke the billion-dollar mark, raking in $1.5 billion in revenue. Meanwhile, analysts project Amdahl will increase its revenue another 21%, to $1.83 billion, and up its net income about 64% to $240 million.

Profitability looks solid: the company's gross margins were 47% of sales in its second fiscal quarter this year, says Edward F. Thompson, chief financial officer, and are expected to hover between 45% and 50% for the remainder of the year.

In the process, Amdahl has gained market share at IBM's expense. However, estimates vary. According to International Data Corp., a market research firm in Framingham, Mass., Amdahl's share of the $14.3 billion PCM market in 1986 was 5.2%, while IBM's was 91.6%. In 1987, according to IDC, IBM's share dropped to 88.6%, while Amdahl's piece of the $15.2 billion market grew to 7.4%. According to a mainframe user survey conducted jointly each year by Boston-based investment firm Cowen & Company and *Datamation* magazine, Amdahl's share of the installed base of PCMs doubled in one year, from under 7% in early 1987 to just under 14% earlier this year.

Watching out for the next zag: "When IBM zigs, we zig," says Amdahl's marketing chief Ted Springstead

Christopher Springmann

Now, Amdahl is back in line following IBM. Currently, the company is working on upgrading its machines so they can run IBM's newest version of MVS, its mainframe operating system, called Enterprise Systems Architecture/370 (ESA). (Amdahl does not provide IBM software. Its systems are compatible with IBM's machines at certain hardware and software interface levels. But Amdahl customers must license MVS from IBM and Amdahl must retrofit its existing machines to run any new version of the operating system.)

IBM started shipping ESA to its customers in July, a month early. Amdahl received its copy of ESA in mid-June. And many analysts think it will be the third quarter next year before Amdahl can start upgrading its systems, enabling them to run the new operating system.

But ESA is presenting more work than Amdahl had expected. In the second quarter, after receiving the specifications for ESA, Amdahl increased its engineering change reserve — the fund used for redesigning existing systems — because ESA, Zemke says, affects more boards within Amdahl's machines than the company had predicted. Zemke will not divulge the amount added to the fund, but concedes the ante may have to be upped again.

Most observers, though, are confident ESA will not create any hurdles for Amdahl. In 1981, IBM revamped MVS. That conversion, called MVS/XA, was a more difficult technical feat. Amdahl was forced to change existing address space to 31 bits from 24 bits. ESA, on the other hand, uses 31 bits.

"ESA is similiar to the situation with MVS/XA," says Kenneth W. Simmonds, president of Teradata Corp. and a former Amdahl executive vice president. "From a technical point of view, it is not a problem." The potential pitfall, explains the Amdahl 10-year veteran, "is that their version will be later. It may affect short-term decisions."

In 1982, before Amdahl was able to respond to MVS/XA, its revenue plodded up 4% while its net income plummeted 75% to $6.76 million. In 1983, though, the company rebounded, increasing revenue 68% to $777.7 million, and net income 587% to $46.46 million.

That is exactly why Amdahl jumped into the storage business in 1982, according to Don Bellomy, an analyst with IDC. "It insulates them a bit," says Bellomy. "The margins aren't as good because they buy directly from Fujitsu." But IBM-compatible direct storage access devices (DASD) have smoothed out the company's revenue stream during down cycles in its mainframe business.

In two years, Amdahl has doubled the number of its *Fortune* 500 accounts

Amdahl entered the DASD market at an opportune time, says Rick Martin, an analyst with New York City investment firm Sanford C. Bernstein & Co. Martin says competitors, like Control Data Corp. and Memorex, were getting away from the business and potential competitors like Storage Technology Corp., were not off the ground yet. In the six years since Amdahl entered the DASD market, storage devices have grown to about 20% of sales.

Amdahl did not get into Unix for the same reason, says Zemke. The company began offering UTS, its version of Unix, two years ago. Amdahl has about 200 licenses for the operating system; half are at AT&T, Amdahl's largest customer. And a number of them run on IBM mainframes, says Dennis Stein, processor product marketing manager.

Zemke says UTS is not an attempt, as some believe, for Amdahl to get out from under IBM's shadow. "There are people who have suggested that with Unix we're really looking for a way to get away from the compatibility business and that's nonsense," claims Zemke. "The compatibility business has made us a billion and a half dollar company."

But UTS may provide an entrée into the scientific and engineering market. Amdahl's vector processors, bought from Fujitsu, are designed for compute-intensive environments. But so far they have contributed little to Amdahl's bottom line. UTS, and a joint development/joint marketing agreement with workstation maker Sun Microsystems Inc., may be more enticing to that market.

Future hurdles

The next compatibility hurdle Amdahl encounters may involve hardware more than software. IBM is expected to bring out its next generation mainframe, nicknamed Summit, sometime in the mid-1990s. International Technology Group, a consulting firm in Los Altos, Calif., for one, believes that IBM will diverge sharply from its existing architecture. In 1995, predicts ITC, IBM will introduce a mainframe that merges MVS/ESA, VM (another operating system) and Application System/400, its recently announced follow-on to IBM's midrange S/3X computers. In addition, it will use gallium arsenide (GaAs) processor logic.

Gene Amdahl, the company's founder and current president of start-up Andor Systems Inc., in Cupertino, Calif., does not think hardware changes pose a dilemma. In competition, says Amdahl, "IBM has two responses. One is FUD, or 'fear, uncertainity and doubt.' The other is to keep changing its architecture, but it has been demonstrated that it can be competed with."

For now, though, IBM does not seem concerned with thwarting the PCM manufacturers by radically changing its hardware. "IBM seems to be more concerned with getting its customers into a new environment as easily and gracefully as possible instead of locking out the PCMs," says Peter Burris, an analyst with IDC.

IBM's third response to competition, some might say, could be price cutting. Some analysts believe that may happen more frequently in the early 1990s, when they expect the mainframe business to become more of a commodity business. Amdahl's Zemke concedes that IBM has become more aggressive in its pricing over the past two years, as demonstrated by its 3090S series mainframes. But he doubts an all-out price war would ever happen.

The only scenario Zemke can imagine that happening in, is if Amdahl achieved a significant share of the PCM market. But even then it seems unlikely, says Zemke. "I'd suggest to you that IBM would be looking around to replace the revenue they had lost to us," says Zemke. "That is the very last time you'd really want to get pricey." IBM, adds Zemke, has other problems anyway. "When the PC business isn't growing and its margins are under attack and the midrange business isn't growing and its margins are under attack," says Zemke, "then you look at the mainframe business to bring more to the bottom line."

Amdahl has had its problems, too. In 1982, the company delivered a new generation of systems, called the 580 series. The systems were a fiasco. They had been announced in 1980 and were late. The machines also did not perform as well as Amdahl had reported they would. To exacerbate the situation, the machines were delivered with numerous bugs. According to Bernstein's Martin, Amdahl had to replace about 100 machines after shipping them.

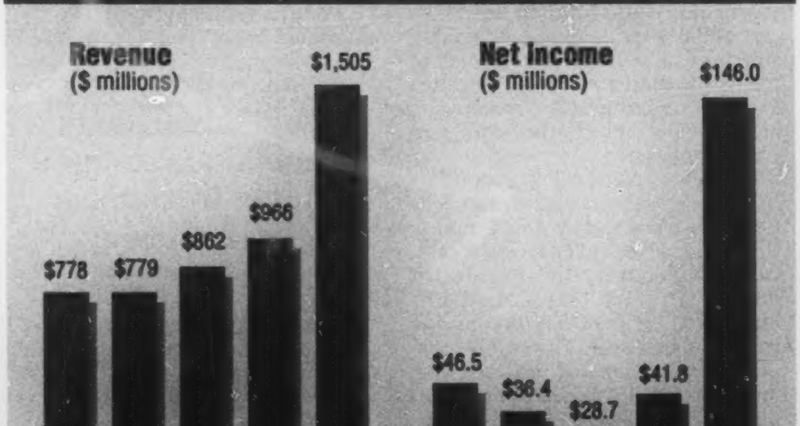
Amdahl's Quality Improvement Process has saved the company about $50 million

After that debacle, Jack Lewis got religion. That's how Roger Heath, director of corporate operations and administration, Quality Improvement Process (QIP), describes the conversion of Lewis, then Amdahl president, to quality management. He hired Phillip Crosby and Associates, a consulting firm in Winter Park, Fla., to improve Amdahl's quality control process after reading Crosby's book, "Quality is Free." The consultant taught 60 Amdahl instructors, who in turn have taught over 80% of Amdahl's workforce, the importance of quality.

Quality isn't free. The consultant has cost Amdahl about $2 million, says Heath. But Amdahl, estimates Heath, has saved about $50 million as a result. The quality program extended well beyond manufacturing departments: for example, Amdahl has cut its accounts receivable in half, saving $18 million in interest expense in one year. Composite production leadtime — from product planning, parts procurement, building and test — has been cut in half, from 66 weeks two years ago to 33 weeks today. The manufacturing cycle time for each board has been reduced from six weeks to 15 days.

Since then, Amdahl's product introductions have been flawless. In 1986, the company began shipping its 5890 mainframes. The systems were on time, performed better than ex-

Amdahl's learned how to keep its net income climbing



Source: Amdahl Corp.

pected and were reliable. By 1987, the 5890 computers accounted for 85% of Amdahl's processor sales, as the 580 series was eventually phased out of production. "Amdahl executed the 5890 perfectly," says Bernstein's Martin. "And it looks like they did the same with the 5990."

The 5990 is the result of Amdahl's first joint development with its Japanese shareholder Fujitsu Ltd. For Fujitsu, the result has been its 2-year-old M780 line of mainframes. But Amdahl contributed about $200 million to the joint development and analysts say the 5990 is not merely a reworked M780.

The 5990 is the first Amdahl mainframe to use very large scale integration (VLSI) semiconductors, supplied by Fujitsu, and an innovative form of water cooling. It also contains the central processing unit on one board, compared with the four boards necessary for the 5890 CPU. Each 5990 board is 42 layers instead of the 14-layer boards used in its predecessor.

According to most analysts, the higher priced 5990 costs about the same to manufacture as the 5890, giving Amdahl generous margins on the machines. But price cutting, in response to IBM's S series, may keep margins closer to the low side.

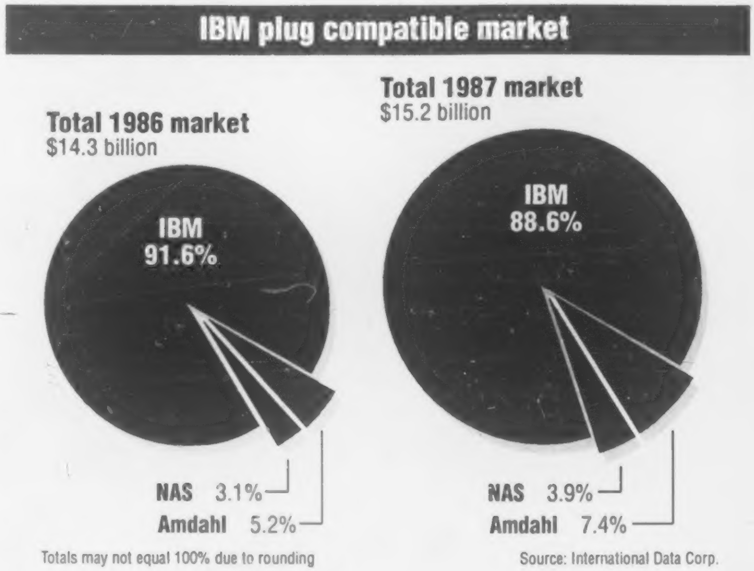
Analysts expect Amdahl to ship about 50 5990 models this year and an additional 125 next year.

Adding Amdahl value

Over the years, Amdahl has taken a lot of flak over its tight relationship with Fujitsu. Fujitsu supplies all of Amdahl's semiconductors, storage devices, communications processors and some of its components and subassemblies.

But unlike National Semiconductor Corp.'s National Advanced Systems (NAS), another PCM maker which resells Hitachi Ltd. equipment, Amdahl is not a distributor for Fujitsu. In fact, says Amdahl's Springstead, Fujitsu has become an Amdahl distributor. The two companies recently signed a deal allowing Fujitsu to resell Amdahl mainframes in Brazil and Spain. A similiar arrangement, where Fujitsu will market high-end Amdahl models in Japan beginning next March, was inked in September.

Amdahl does not expect any of those foreign markets to contribute noticeably to its revenue. "They are not significant in terms of volume," says marketing executive Springstead. "But it is symbolic. Symbolic of the value we add as a company when you can sell back to your major shareholder gear that embodies a lot of his components in the first place."



Totals may not equal 100% due to rounding

Source: International Data Corp.

Both Amdahl and NAS are gathering market share at IBM's expense

In addition, says Springstead, Fujitsu's stake in Amdahl makes for a stable investment environment. A $1.5 billion company, with over $580 million in cash, would normally be ripe for takeover, says Springstead. "A lot of management time would be wasted on worrying about that," says Springstead. "Here we don't even think about it."

Fujitsu's stake in Amdahl makes for a stable investment environment

Amdahl also offers unique products that differentiate it from IBM. UTS, its Unix operating system, is one example. It is a native operating system, unlike IBM's Unix, called AIX, which must run under VM. Another is Amdahl's Multiple Domain Feature (MDF) announced in 1984. Developed for internal use, as was UTS, MDF allows four separate operating systems to run on one processor. In May, the company enhanced that to seven domains on certain systems. IBM now has a similiar product, called Processor Resource/System Manager (PR/SM).

Displaying leadership, as demonstrated by its leapfrogging IBM in product cycles, impresses customers, too. But while Zemke says he is proud of the company's accomplishment in bringing the 5990 to market quickly, he doesn't want to get trapped into outdoing IBM every time. Staying compatible, after all, is the company's first priority. "Every product has an absolute requirement that it be compatible," says Zemke. The early introduction of the 5990 happened, says Zemke, "because at that particular point in time we were well positioned to take another step. It doesn't say we will always do it."

The immediate future involves catching up with IBM's ESA and delivering compatibility for the operating system on all Amdahl systems. There is also the next generation of hardware to be developed. Says IDC's Burris: "Amdahl is going to be dancing fast and furious for the next three years." ☐

Atten-shun! You will now design ASICs the military way

The Pentagon is mandating VHDL as a standard design language for ASIC contracts. IBM is falling in, but CAE leaders will be tough to recruit

BY DAVID CARD

Starting this month, every custom chip that goes into a Department of Defense system will have to be described in the DOD's new design language. Right now the only tools which allow that come from untried CAE companies. Has the DOD gone contrary to commercial reality again?

Not so, claim supporters of the language, dubbed VHDL for "VHSIC (very high-speed integrated circuit) hardware description language." In contrast to Ada, the DOD's long-suffering software programming language, VHDL spec-setting was opened to the public early, resulting in an IEEE standard last winter. Nor is there much in the way of commercial competition for VHDL — Ada faced popular and proven programming languages like C and Pascal.

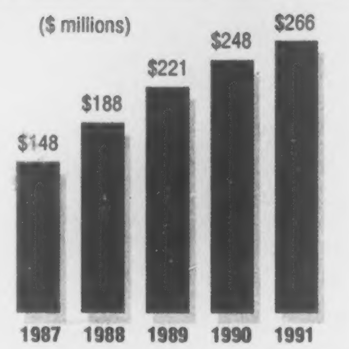
Consequently, firms like National Semiconductor Corp., IBM and Viewlogic Systems Inc. are positioning themselves to cater to a market that, while only now emerging, could be worth hundreds of millions of dollars by the early 1990s.

The issue is one which affects the entire electronics industry, because most observers agree that VHDL will likely be as close as the industry comes to having a single design language, for commercial as well as military use. Should it gain widespread acceptance, VHDL could conceivably double the market for behavioral simulation tools, say some observers. However, there's still debate about how firmly entrenched the new language can become.

A hardware description language (HDL) is used by designers to model a system in a lot of abstract detail. Instead of employing graphic representations of circuitry, HDL defines the system in terms not unlike computer code. This makes for a top-down system design strategy, incorporating "behavioral" simulation — which models the function of a system rather than the performance of individual circuits — as well as more traditional logic and fault simulation.

Even VHDL critics admit that it is a particularly rich language. VHDL allows structural and functional descriptions of all or part of a system — from individual chips to chips on a board to a complete hardware/software combo. John Hines, the VHDL chief out of the VHSIC design group at Wright-Patterson Air Force base, says the DOD will "save literally billions of dollars, long-term," if everybody adopts VHDL. Designs won't have to be redocumented, and different simulators will produce the same results. "The DOD can't do anything with the garbage we're getting — and paying for now," Hines says.

IC simulation/verification software sales



Source: Dataquest Inc.

Some say VHDL could quickly double the market for behavioral simulation tools

That garbage is schematics. But getting designers to abandon schematics is going to take some doing. The CAE market is based on bottom-up, graphics-oriented design styles, resulting in schematics rather than computer science statements. Industry-watcher Andrew Rappaport of The Technology Research Group in Boston says that whether engineers will change styles is "the $64 million question." Even Hines has written papers admitting that only 10% of engineers with workstations are familiar with HDLs.

So it is hard to hear anything but lukewarm support for the language from the major CAE vendors. Few custom chip houses are far along in their VHDL efforts either.

There are plenty of other hindrances to wide VHDL acceptance, including the usual technical bickering as well as unapproved subsets of the language and an installed base of non-VHDL tools. There is also an intellectual property protection issue. The DOD wants VHDL so that it can guarantee support for designs, but behavioral descriptions of chips make it easier to copy a design and make a functionally equivalent chip.

It all adds up to an industry quandary. "I'm afraid it might become one of the biggest boondoggles perpetrated on this industry," worries Prabhu Goel, president of CAE simulator company Gateway Design Automation Corp. Goel does not blame the DOD: "Their goals were farsighted. It's the process that is becoming a boondoggle." Gateway does license its own HDL, but not as a competitor to VHDL, says Goel.

Tied hands

Defense electronics giant TRW Inc., a Gateway customer, uses VHDL, but only because it is forced to by VHSIC contract, according to

A sampling of VHDL support

CAD Language Systems
(Rockville, Md.)
- tool set for developing VHDL to conventional CAE hookups
- start-up, Intermetrics spin-off

IBM (Armonk, N.Y.)
- announced support for VHDL input
- original VHDL contractor

Intermetrics
(Cambridge, Mass.)
- full line of VHDL analyzers, simplifiers, simulators
- the original VHDL contractor but little CAE experience

Logic Automation
(Beaverton, Ore.)
- third-party VHDL models
- marketing agreements with Vantage, CAE, chip companies

Microelectronics and Computer Technology
(Research Triangle Park, N.C.)
- VHDL used in CAE project, working on VHDL verifiers
- CAE project being drastically revamped, for members only

National Semiconductor
(Santa Clara, Calif.)
- VHDL models for custom division
- first big player with native VHDL support

Quadtree (Milpitas, Calif.)
- third-party VHDL models
- marketing agreements with Vantage, CAE, chip companies

Seattle Silicon
(Bellevue, Wash.)
- Navy contract for VHDL connection to silicon compiler
- compiler company cum design broker

Silvar-Lisco
(Menlo Park, Calif.)
- multi-part CAE project: first translators, then simulator
- IBM resells some Silvar-Lisco software

Texas Instruments
(Dallas, Texas)
- marketing arrangements with modeling companies
- original VHDL contractor, translations only

Vantage Analysis Systems
(Fremont, Calif.)
- VHDL behavioral simulator and front end
- start-up, Silvar-Lisco spin-off

Viewlogic Systems
(Marlboro, Mass.)
- simulator with VHDL subset
- marketing agreements for VHDL models

Zycad
(St. Paul, Minn.)
- Endot VHDL behavioral simulator in the works
- base in conventional CAE accelerators

Source: ELECTRONIC BUSINESS

Horace Bowser, a TRW CAE software engineer. He's had to write add-on programs to compensate for VHDL timing problems. VHDL is too rich and flexible, Bowser says — chip simulation outputs from second source suppliers' versions don't match up.

Still, IBM, for one, has announced support of VHDL. And General Dynamics Corp. would also like to design in VHDL, according to David Evans, who heads electronics design for GD's Data Systems Division in San Diego. "But my hands are tied," Evans mourns. "I'm beating on the tool vendors."

One such vendor, CAE leader Mentor Graphics Corp., is illustrative of the industry's casual attitude toward VHDL. Mentor president Gerard Langeler says Mentor is "not just interested, we are committed" to VHDL, then in the same breath he boasts that Mentor is working on its own proprietary description language as well.

Leading custom chip makers are no more enthusiastic. "Right now, we're not doing anything in response to VHDL," says Van Lewing, software marketing director for LSI Logic Corp. He says he hasn't seen any "hardball tactics" by customers demanding VHDL support. Likewise, VLSI Technology Inc. has little desire to change its internal simulator over to a VHDL-oriented one, according to marketing manager Daniel Skilken. Both companies are planning translators that would generate VHDL descriptions of parts from their simulators — a technique that may not be acceptable to the DOD.

Untested players

Wright-Patterson's Hines says that there are plenty of options for pure simulators, but he points out only three — from Intermetrics Inc., Endot and Vantage Analysis Systems Inc. Intermetrics, while a big player in custom software for the defense industry (it was prime contractor for the original VHDL, with subcontracting by IBM and Texas Instruments Inc.), has much less of a record in CAE.

Endot, a Zycad Corp. subsidiary, has 14 beta sites for its VHDL-oriented simulator, but president Mark Parsinen says he doesn't want to "bite the schematic tar baby." That is, Zycad will still support the more traditional graphic methods of design with most of its product line.

Parsinen thinks that VHDL will help to standardize the top-down style of design and could lead to a larger market for behavioral simulation. "It probably doubles or triples the market," he says, which might make for a "conservative quarter-billion dollar market by 1990."

Vantage president Ronald Abelmann is more conservative. He estimates that the behavioral simulation market is a $20 million segment of a $125 million overall simulation market now, becoming half of a $400 million business in five years. San Jose market research firm Dataquest Inc. puts the entire simulation/verification market at $422 million this year, well over half of it hardware, but has not figured out the behavioral or VHDL segments.

One company, CAD Language Systems Inc., is working with some CAE vendors to develop a VHDL front-end for their design systems, and more familiar CAE names like Silvar-Lisco (some of whose software IBM resells) and Viewlogic Systems Inc. are aggressive in their VHDL efforts.

Heavy hitter

And one heavy-hitting chip maker, National Semiconductor Corp., is getting very serious about VHDL. "We're taking the bull by the horns," says Roy McGuffin, design automation director for National's custom business. "We're going to offer VHDL-native models" in the fourth quarter of this year. National is Vantage's largest customer, although it also supports simulators from Gateway and GenRad Inc. National will still resimulate designs that come in in VHDL form — on non-VHDL simulators.

But do these players put enough weight behind VHDL? Analyst Rappaport says that the DOD must meet the industry halfway on two points: to cater to technology-rights worries, it will have to figure out some way of putting designs in escrow — safely locked away until a second source might be needed. And Defense will have to knuckle under and ratify some subsets and make allowances for translations.

When that is done, VHDL may emerge as an industry standard for commercial as well as military designs — a process that could take five years. ☐

Issues in manufacturing: The view from the top

A poll of 100 vice presidents for manufacturing suggests that the skilled labor shortage could be driving up the cost of blue-collar wages

BY ROBERT SNOWDON JONES

Despite extensive use of offshore manufacturing labor, U.S. electronics firms are continuing to have a hard time finding skilled workers at home, according to the latest ELECTRONIC BUSINESS survey of vice presidents for manufacturing and other plant managers.

The survey is based on about 100 responses to a written questionnaire mailed by ELECTRONIC BUSINESS to close to 1,000 manufacturing managers earlier this year. Six out of 10 managers surveyed said they worked for companies with sales of under $50 million.

Of primary concern to many of these companies was the rising cost of blue-collar wages in the high-technology sector. Our survey indicates that the average per-hour pay for skilled labor in the electronics industry is now $11.30. At the same time, unskilled labor receives an average $7.31 an hour.

Sixty-nine percent of the managers polled also said they would increase salaries 1% to 5% by Sept. 1, 1988. Only 2% said they would increase salaries 6% to 10%, and 7.5% of the respondents said they expected no change in salary levels.

Curiously, though, wages are increasing even though many managers continue to be unimpressed with the productivity of the American worker, compared with his Far Eastern counterpart. Only 7% of our respondents said the American was more productive than the Asian worker. At the same time, thirty-seven percent said U.S. productivity was lower; and 36% said United States and Asian workers are evenly matched.

Our survey also indicated that despite rising wages and complaints about lower productivity, union participation among American electronics workers still remains to be relatively low. From our survey, we found that only 13% of the respondents' plants are unionized. The International Brotherhood of Electrical Workers (IBEW) is the most dominant union. Our respondents reported, too, that unions have tried to organize at 17% of the non-unionized companies polled. As a result of what the poll indicated, the most active unions in the electronics sector included the IBEW, the Teamsters and the United Auto Workers.

Twenty-nine percent of the managers surveyed said their plants use some form of robotics

Jon McIntosh

The overriding concern of American plant managers, our survey suggests, is the availability — or lack thereof — of skilled, versus unskilled, employees. "Guys who are not engineers but are fluent in technology are hard to find," says Christopher J. Ross, vice president for manufacturing for Spectragraphics Corp., a San Diego-based maker of computer graphics workstations. "The ones who are sharp don't stay in manufacturing. The ones that want to get into an electronics career go one step further and go into engineering."

Keeping skilled workers

Because of acute labor shortages in some locations, companies are paying more attention to retaining valuable employees, managers say. And they are finding out that it isn't just direct monetary awards they're after.

"The skilled workers I interview from other companies say they've got a job, but they want a career," says George Irwin, vice president for manufacturing at Appliance Control Technology Inc. in Addison, Ill. "The gray-collar worker is in high demand. He knows it and is looking at quality of life. We try to get them involved and make them feel part of the company."

Labor shortages aren't a universal problem. Much of it depends on geographic area. Kurt Bankord, manager of manufacturing support and depot repair for Phoenix-based Syntellect Inc., says, that getting good technical employees isn't a problem for his company. The Phoenix area has several large electronics installations, including those owned by Intel Corp. and Motorola Inc. It's a perfect hiring ground for a small, fast-growing company like Syntellect, Bankord reports.

That's not the case in the Silicon Valley, where experienced labor is in

Jon McIntosh

Of concern to many managers is the rising cost of blue-collar wages in high-tech

short supply. "Out of every 100 people who apply, 98% are rejected," says Ron Rapczynski, vice president of Engineered Circuit Research Inc., a Milpitas, Calif., medical and military electronics contract manufacturer.

Boom in SMT

One way firms are dealing with the labor shortage is by investing more heavily in new, highly automated capital equipment. Forty-two percent of the respondents to the survey, for example, said they have incorporated some surface mount technology into their operations.

The boom in SMT reflects, in part, the fact that many high-tech firms are rapidly moving up the learning curve in advanced manufacturing technology. Engineered Circuit Research's Rapczynski is perfectly blunt about SMT: "We believe it's where the technology is going."

He says his company is making boards that contain 340 pins with 20-mil centers. "You can't do that with a through-hole part," he says, referring to the older form of inserting components into printed circuit boards. Within the Silicon Valley in the past six months there has been a marked increase in the use of surface mount techniques, he says.

Those companies that have problems manufacturing PCBs with surface mount are in trouble because they don't know how to design the boards, Rapczynski contends. "We prefer to get involved early on in the design stage," he says. "Through-hole is a very forgiving process. Surface mount is metal-to-metal bonding. The best surface mount designs are made by people who build from the manufacturing perspective."

But as the results of the ELECTRONIC BUSINESS poll reflect, not everyone in manufacturing is overwhelmingly enthusiastic about SMT. "Being a new technology, we weren't comfortable with surface mount's maturity," Bankord of Sytellect notes. "We don't think it's completely reliable for our needs," he says. The company's voice response system would require a 30% to 40% through-hole circuit board if surface mount were used, he says. "That's harder to lay out and make than either kind of board. The cost takes away from the attractiveness," says Bankord.

JIT solutions

To offset high manufacturing costs, electronics is also turning increasingly to just-in-time inventory control, a process that involves getting materials and parts to the factory floor "just in time" for manufacture. Seventy-one percent of our respondents said they use JIT to some degree.

"In certain applications it works well," says Irwin of Appliance Control Technology. But components from overseas have to be ordered far in the future in order to use the technique. Low-tech but essential items also don't fit well into a JIT strategy, Irwin says. The corregated boxes the appliance control maker needs are sold by the ton. "I have to buy in large quantities to get a good price," Irwin says.

In addition to JIT, electronics firms are also continuing to experiment in "quality circles." Quality circles were in effect at four out of every 10 manufacturing plants surveyed.

Robotics also appears to be making some headway. Twenty-nine percent of the managers surveyed said their plants use some form of programmable automation. A similar ELECTRONIC BUSINESS survey taken two years ago showed that 22% of the companies had robots.

Some of these statistics about the shift to increased automation may be deceiving, however, some consultants caution. Many companies try these productivity techniques only to abandon them later, said one. "The problem with U.S. companies is, they can't implement these techniques," says Joel Polakoff, senior manager in Chicago for the accounting firm of Seidman & Seidman, which specializes in electronics manufacturing.

Modern efficiency methods fail at many companies, he argues, because of inadequate planning, not because they are not viable ways to gain productivity. American companies are also too impatient to adopt methods that might take four years or more to return their investment. "They

Union participation among American electronics workers still remains low

want it done now and these are long-range systems," Polakoff says. "You can't quantitatively show pay back in short term, so many new ways of doing things don't get tried."

Offshore manufacturing

One trend that does not seem to be abating, however, is the shift toward offshore manufacturing in the cheap labor markets of the developing world. Forty-three percent of the managers surveyed said their companies have operations outside the United States. Mexico is the most frequently mentioned location for non-U.S. plants — with 17 of 40 managers who responded to this question saying they have set up plants there.

Mexico has become popular because of its proximity to the United States and the willingness of Mexican assemblers to work with small U.S. companies, managers said. Also, contract manufacturers are increasingly turning to Mexico to set up operations there.

"The big trade-off of going down to Mexico is that it takes longer to do things down there," according to what Ross of Syntellect says. "You've got more stuff in float."

As an offshore site, Mexico was followed in popularity by eight managers who named Singapore as the main site for their offshore location.

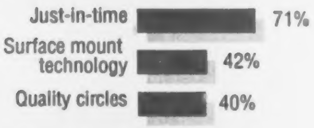
Most of those companies surveyed, however, only do a small portion of overall manufacturing overseas. Fifty-seven percent said they carry out under 10% of their manufacturing operations offshore.

Half of those managers whose companies have offshore plants said they don't expect an increase or decrease in the use of offshore labor over the next five years. Only 5% expect a more than 50% increase. ☐

ELECTRONIC BUSINESS manufacturing survey

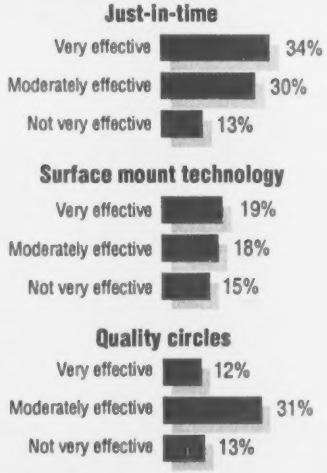
Which of the following manufacturing techniques does your company employ?

Multiple responses allowed

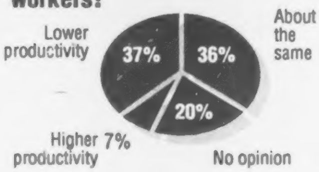


How would you rate the degree of effectiveness for these manufacturing techniques within your company's operations?

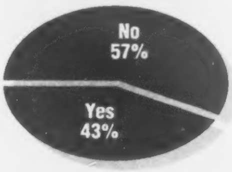
Multiple responses allowed



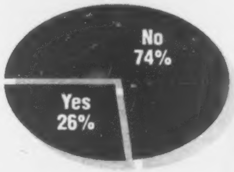
How would you rate the productivity of American versus Far Eastern production workers?



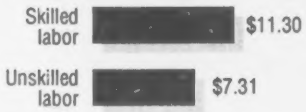
Does your company maintain a manufacturing operation outside of the U.S.?



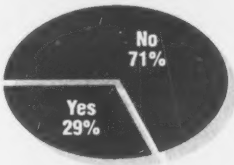
Are you experiencing any labor shortages within your manufacturing operations?



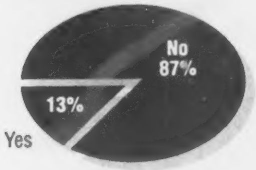
Including benefits, what is the average rate paid to your company's production workers?



Do you use programmable industrial robots in your manufacturing operations?



Are any of your manufacturing workers unionized?



Source: ELECTRONIC BUSINESS

Disk arrays: Here come the disk drive sextuplets

Disk arrays — rows of disk drives bundled electronically — may be one answer to fault tolerance. It's up to the users to decide

BY JOHN M. DODGE

A disaster looms in data storage — storage devices just can't keep up with the blazing speed of faster and faster central processing units (CPUs). And some disk makers argue that disk arrays — hard disk drives lashed together electronically — may be the down-and-dirty solution.

The problem, of course, is not a new one. Faster CPU speeds are tearing past the ability of storage mediums to serve up data in a timely fashion. As a result, magnetic disk drives are savaging CPU speeds and ultimately the overall speed of computers. And it is faster computers that will give rise to long sought computing applications such as client/server databases, distributed applications and graphics.

As CPU speeds continue to accelerate (40% a year has historically been the rate with single chip computers), storage will fall further behind. Magnetic media is at least three orders of magnitude slower than CPUs and associated memory. According to Sun Microsystems Inc. cofounder William Joy, when CPUs increase tenfold in speed, the computer will only run faster by a factor of five times. Using that same formula, the input/output (I/O) bottleneck reduces a 100-fold CPU increase by 90%, in terms of total computer performance.

Another key to unlocking new technologies is data reliability. Today's technology makes fail-safe data availability and integrity an expensive and inefficient proposition — yet it's frequently as necessary as the computer itself.

Why then, have drive makers and system builders moved so cautiously with disk array technology, a potential answer to both problems? Because disk array must overcome several obstacles, many of them commonly associated with emerging technologies. Industry experts say widespread acceptance of disk array usage must contend with scrawny profit margins, a prerequisite education process to get the market excited, and the ominous presence of the larger computer companies. A more fundamental question is whether the technology represents a new product opportunity or a value-added repackaging of existing disk drives.

Understanding in detail how the technology works requires years of drive development experience, but essentially it involves electronically bundling disk drives, typically six at a time. Typically, too, the drive spindles are so synchronized that all the drives in the assemblage begin logging in data at the same point in time. All of the drives in the array are under the command of the same controller. In this way, blocks of data are "striped" electronically across a group of drives, thereby providing a degree of fault tolerance — computer-based systems that theoretically can't crash and, in the process, destroy data.

Priam's John Titsworth suggests disk arrays could find a niche in CAD/CAM and other applications requiring fast transfer rates

Liane Enkelis

Multiple benefits

Disk arrays therefore offer two major benefits — high data reliability and extremely fast I/O or data transfer rates. Typically, one unit is dedicated to storing parity data — codes normally associated with error correction; the other five are for business data. Should one of the five data drives in a six-unit configuration fail, the data can be recreated by a sophisticated error correction algorithm and the parity data. A failed data drive will only slow the system down, but data availability and integrity are maintained throughout.

The technology has been around for some time, but its origins are hard to trace. Some credit Tandem Computers Inc. A more distinct possibility is IBM's so-called "check summing" procedure, which recreates data on failed System/38 and AS/400 disk drives through parity information.

In theory, disk arrays will reduce the bottleneck with high data transfer rate. In doing this, the speed by which this is done is calculated by multiplying the data rate of each drive by the number of units. "Each time you add a drive, you get much higher data [transfer] rates," says John Titsworth, president of San Jose-based Priam Corp., which will be producing disk array products soon. Applications requiring high data rates include graphics, CAD/CAM and databases where large

The disk array market just "ain't there yet," Seagate director of marketing development Carter O'Brien points out

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blocks of data are frequently moved.

Disk array and fault-tolerant technologies have also spawned new acronyms, such as mean time between data loss (MTBL) and mean time to data availability (MTDA). Clearly, data storage is advancing the old standard — mean time between failure (MTBF). MTBL can be in the 500,000 to 750,000 hour range. "That's 55 years of continuous operation. Let your children worry about the next failure," quips Chet Baffa, senior vice president for marketing and sales at Micropolis Corp., Chatsworth, Calif. Micropolis is one of two known vendors to have disk array products available on the market.

What's holding the market back is perceived uncertainty over customer need. Paying for fault tolerance you don't need does not make sense. Generally, personal computers (PCs) are not used for fault-tolerant applications, although that is likely to change with the advent of Intel 80386 database servers under OS/2, the new IBM PS/2 operating system. At OEM pricing, disk array requires special error-correction software, a master controller and spindle/actuator synchronization, all of which can more than double the cost per megabyte of 3.5-inch and 5.25-inch storage from its current lows of $3 to $5 per megabyte. End-user pricing — as high as $24 per megabyte, according to San Jose-based market research firm Dataquest Inc. — is exorbitant.

Fears abound

Another fear facing drive makers in particular is that disk array technology will be implemented by the large systems makers such as Digital Equipment Corp., IBM and Tandem, thus eliminating a sizable chunk of their potential market. "It's a replay of the floppy disk market. When it becomes big volume, they will want to do it themselves," says Micropolis' Baffa. Jim Porter, president of Disk/Trend Inc., a Mountain View, Calif., research concern, agrees: "Some of the companies that have been pioneering in this area have become discouraged. Generally, it is expected that most mini makers will do their own thing with [disk arrays]."

So far, though, the big computer makers do not appear to be taking the plunge. A Tandem spokesperson would only say that the company is "investigating the possibility." A Digital Equipment Corp. spokesperson says the company "considers all good technologies." However, the recent introduction of SA600 large disk drives incorporating a "predicted maintenance" fault-tolerant approach indicates that as far as DEC is concerned, disk arrays are a ways off, says Gerry Atterbury, vice president of peripherals at Dataquest. Even though DEC calls them "arrays," they are actually 1.2-gigabyte drives that are clustered together with software that indicates when something is amiss. Then an operator can shut down a unit or replace it.

The sum of its parts

IBM implements what it terms a check summing scheme, which differs from disk arrays, according to Brian E. Clark and Terrence J. Stewart, two of five inventors named on a patent application to protect part of the process. For example, it does not require disk synchronization; and rather than put parity data on one drive, IBM spreads it over several drives, Clark and Stewart explain. Both are programmers at IBM's Rochester, Minn., disk drive complex.

The advantage, they point out, is that their version does not tie up all the drives, and as a result can do many simultaneous read and writes; disk arrays, on the other hand, read and write data one block at a time, giving it the effective transaction processing rate of only a single drive, albeit at very high data transfer rates. Until disk arrays can get around this problem, they will probably be de-

Auspex founder Larry Boucher believes disk arrays only represent an opportunity for companies already anchored in the drive business

nied another piece of the market — that of processing high volumes of small bits of data. Disk arrays, on the other hand, won't crash a system, whereas IBM's process will. Either way, they perform the critical task of data recovery. But as for broader disk array technology, IBM reserves comment on its position — although some experts, such as Atterbury, believe IBM's again aging 3380 large disk drives would be an ideal target for it.

Search for the mainstream

Even though a healthy distance between disk arrays and big computer companies exists for now, Micropolis, says Baffa, is considering shelving the technology. Currently, the company is test marketing a 1.5GB workstation and mini-configuration made up of four 380MB data and one parity unit. The drives are 5.25-inch with SCSI interfaces. "If we conclude it cannot be mainstream enough, we will probably pull back," says Baffa. He declines to name distributors and value-added resesellers (VARs) interested in the product, but judging from Micropolis' experience, the response has been less than enthusiastic.

"I have not even heard of [disk arrays]," says Preston Heller, chairman of Pioneer Standard, a Garfield, Ohio, disk distributor. Heller points out that the drive market, especially for PCs, is a volume commodity market where margins are razor thin or even nonexistent. "It's very competitive," he notes.

"'It's really hard to say whether or not this is a market,' according to some experts. How much value is added actually doing this? A disk array is really a disk drive with certain characteristics and potentially better performance. Does the customer want to pay the added tariff? I don't really have a sense for that yet," according to Larry Boucher, president and founder of Auspex Inc., a Santa Clara, California, start-up that will probably employ disk array technology, but not base its business on it. Boucher is the founder of disk drive controller maker Adaptec Inc. and the inventor of the SCSI peripheral interface.

Disk arrays offer two major benefits — high data reliability and fast data transfer rates

Disk arrays only represent an opportunity for companies already anchored in the systems or drive business, Boucher posits. A company basing an entire business plan on it has a lower chance for survival, he says. "How do you get in between drive and systems companies and make money?" he asks. Pacstor Inc., of Los Gatos, Calif., is trying to do exactly that. Bucking the odds, 1-year-old Pacstor is selling into the largely non-fault-tolerant PC marketplace and is neither a systems nor a drive maker. Rather, it buys drives, adds value with error-checking software and controllers and resells them as disk array subsystems.

Pacstor recently started shipping three versions of its Integra array storage subsystems. Using 3.5-inch drives, the high-end Pacstor system boasts an access time of 4 milliseconds, a data rate of 1.25MB per second and a mean time between data loss of a whopping 750,000 hours (85 years). Prices on the high-end Integra III with 12 100MB drives and 80386 intelligence to handle up to 16 microcomputers, start at $9,000 in 750-unit quantities. With networks at the forefront of PC fault tolerance, Pacstor smartly has made the line compatible with Novell Inc. and 3Com Corp. network operating systems, as well as PS/2s, PC ATs and Unix.

Keep it simple

"The sales effort to educate the prospective customer base regarding the benefits of array processing will be expensive. Yet, Pacstor has a chance to make it big," writes Dataquest analyst Phil Devin in a newsletter. Devin pegs end-user cost per megabyte at as high as $24.

Pacstor is the creation of John Kevill, a 30-year veteran of IBM, DEC, Storage Technology Corp. and Memorex disk drive adventures. He lists relevant PC applications as transaction processing, desktop publishing, CAD/CAM, telecommunications, military programs and process control.

At a demonstration at Spring Comdex in Atlanta, one of 12 drives was unplugged and one-twelfth of the picture on a PS/2 Model 80 monitor disappeared. Another was unplugged and another twelfth vanished. When the error correction was activated, the entire picture was restored.

Still, Pacstor and Micropolis stand

Liane Enkelis

alone in the small computer market. Analysts agree that if client/server databases and mission critical applications on PCs become reality, and there is every expectation they will, Pacstor can cash in on visionary status. It's too early to tell what success Pacstor is enjoying and Kevill declines to release distributor or OEM customers who are just receiving the product. Either way, Pacstor should be able to hang on for some time, given that its major backer is established keyboard maker Key Tronic Corp., which will do manufacturing and provide support.

Besides Micropolis and Pacstor, activity on the PC side is in its early stages. On the minicomputer and mainframe side, disk arrays seem to be getting on track. "We are actively evaluating the array business and looking at smaller diameter drives to develop high performance," says Errol Heiman, intelligent peripheral interface (IPI) product manager for Fujitsu America Inc.'s Intellistor subsidiary in Longmont, Colo.

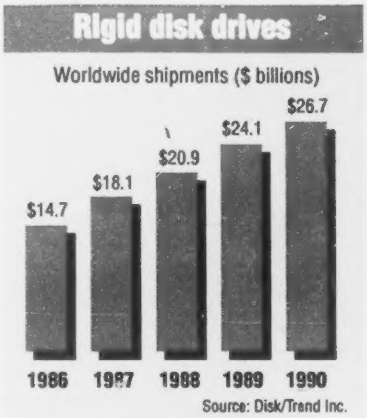
A low-end explosion

The explosion in demand for 3.5-inch and 5.25-inch drives has driven cost down so far that when configured in disk arrays, they represent a less expensive solution than less reliable and slower single versions of 8-, 9-, 10.5- and 14-inch drives, according to Amil Vasudeva, director of system products for Fujitsu in San Jose. This year, 3.5-inch drives will pass 5.25-inch drives in volume at an 8 million crossover point.

By 1990, more than 20 million 3.5-inch drives will be shipped. Quantities for the larger diameters will all be under 500,000, with 5.25-inch drives dropping to about 4 million, according to Disk/Trend.

For a 3.5-inch drive, OEM prices are reportedly in the area of $3 to $4 per megabyte in volume orders. Fujitsu believes the technology has a bright future, but is not ready to commit to it. "I think Micropolis is ahead of the market by about two years. There's a lot of concern about 5.25-inch and 3.5-inch [drive] reliability, and that they can't tolerate the high data rates," Heiman says.

Thus, optimally configured array systems have the potential to shatter the I/O bottleneck issue and enable systems to realize their processing potential. The largest volume producer of 5.25-inch hard drives, Seagate Technology Inc., is more cautious. "It ain't there yet. You don't want to get all sucked up into vendor hype. I'd say we are more at the R [research] stage than the D [development] stage," says Carter O'Brien, Seagate director of market development. As mini and mainframe applications such as communications, graphics and number crunching migrate to PCs during the next two years, a genuine need for disk arrays will emerge, he says.



Source: Disk/Trend Inc.

While disk arrays are attractive because of their fault-tolerant capabilities, they still represent well under 1% of all rigid disk drives shipped this year

Disk arrays are certain to be recognized as one solution to the I/O bottleneck

Control Data Corp. also is being cautious. "There is no one disk subsystem suited for all applications. In choosing a storage solution, systems integrators must address the important attributes for specific applications and should deal with formatted capacity, data rate and cost," writes Al Sharon, manager of technical sales support in Control Data's Storage Products Division, in a report called "Disk Array or Disarray?"

What bothers Sharon is formatted data storage efficiency. In an array for four data drives (and one parity), 512K sectors of data are split into four 128K sectors, one for each data drive. Given that each sector carries the same amount of "overhead" data (data associated with formatting), formatted capacity for data drops from about 85% for a single drive to 64% in a disk array. However, that's a lot better than the standard 50% for fault-tolerant shadowing, Sharon notes. "We are not offering it," he says, but the chances are that Control Data eventually will. Like the others, Sharon sees arrays best suited for graphic and CAD/CAM applications. Fault-tolerant and single drive configurations are better suited for transaction processing and general business applications when it comes to cost and performance.

Striving for efficiency

A strong disk array supporter is Amperif Corp., of Chatsworth, Calif. "We are very enthusiastic, but we'll be in the mini and mainframe market, not the PC market," says Steve Fuld, vice president of business development and strategy. Amperif is developing an IPI controller and expects a warm reception from mainframe system and drive makers. "For such specialized applications like image processing, you need high data rates for large I/O transfer. It's not a PC market... [IBM PC] ATs cannot handle high data rates," Fuld explains. Potential customers include Fujitsu, Gould Inc. and Unisys, Fuld adds.

Sequent Computer Systems Inc., a Beaverton, Ore., supplier of Unix minis for transaction processing, is also optimistic. "Unlike some systems makers, it will look to the outside for the technology," says Mike Altree, I/O systems manager at Sequent.

At some point, disk arrays are certain to be recognized as one solution to the I/O bottleneck. For now, however, the bottleneck is more in the minds of engineers and academics than the market psyche. With some education, increased emphasis on the small computers and recognition that new applications are vital in keeping America competitive, disk arrays have a place. For the pioneers with vision, guts and the smarts to find out where the shoe fits best, there should be a payoff. ☐

Precocious desktop publishing gets growing pains

A new industry faces an old problem. Desktop publishing equipment makers, like other high-technology businesses before them, are facing a shakeout

BY STEVE GROSS

Although scarcely 2-years-old, the personal computer desktop publishing industry already is looking to the future. Indeed, in a market that some believe will move from birth to maturity in only five short years, the shakeout phase of the cycle may already be approaching.

That's because so many competitors have been drawn to a field where rapid growth has been fed by lower prices for essential computer equipment, particularly laser printers. Creative Strategies, a Santa Clara market research firm, predicts that the desktop publishing market will reach $2 billion this year and $5 billion in 1992. Software and hardware sales are about 30% and 70% of the market, respectively.

Software side

The software side of the desktop publishing market is dominated by Xerox Corp.'s Ventura Publisher and Aldus Corp.'s PageMaker. By their own estimates, the two equally share from 80% to 95% of the dedicated desktop publishing software market for MS/DOS machines.

Perhaps 20 or 30 smaller software firms, such as Letraset of Paramus, N.J., compete for the rest of the market. Letraset, for example, claims to have 28% of the Macintosh portion of the desktop publishing software market; software for the Macintosh may, in turn, constitute a third or more of the total desktop publishing software market. Software vendors say that there's room at the top for a few more key players, but not many.

Xerox's Carolyn Grossman: "I think there will certainly be more than two desktop publishing companies"

Peter Poulides

"I think there will certainly be more than two desktop publishing companies, and probably three or four," says Carolyn Grossman, San Diego-based manager of customer support and documentation for Xerox desktop software. She predicts that Xerox and Aldus will be among the top competitors, and notes that Interleaf Inc. of Cambridge, Mass., a player in the high-end workstation market, also may become a force in PC desktop publishing. Other competitors, she contends, must overcome "the stranglehold on the market" by Xerox and Aldus.

Some smaller players may survive as niche marketers or as product development houses for larger firms with more marketing clout. Xerox has fostered the latter strategy by using marketing agreements with third-party development firms including Ventura Software, developer of Ventura Publisher, and more recently Cricket Corp., a Malvern, Pa., creator of graphics and drawing programs.

Grossman says Xerox expects industry-wide dedicated desktop publishing software revenue to reach $120 million in 1989. "I don't think this market will even start to flatten until 1990," she says. "Then year-over-year growth will start to slow down." Growth will plateau in the early 1990s, she predicts.

Tim Bajarin, executive vice president of Creative Strategies, isn't ready to predict a shakeout in desktop publishing. But he points out that dedicated desktop publishing software firms like Xerox and Aldus can expect more competition from well-established word-processing programs such as Microsoft Word and Word Perfect. Those programs might tap into the low end of the desktop publishing market with additional features, he says.

"All the word-processing guys are aggressively adding desktop publishing to their programs," according to Bajarin. "And all of them have a strong installed base of products [to which] they can sell upgrades." As a result, he says, the dedicated desktop publishing software firms may be forced to upgrade their own programs to keep ahead of the word-processing firms.

Technical barriers

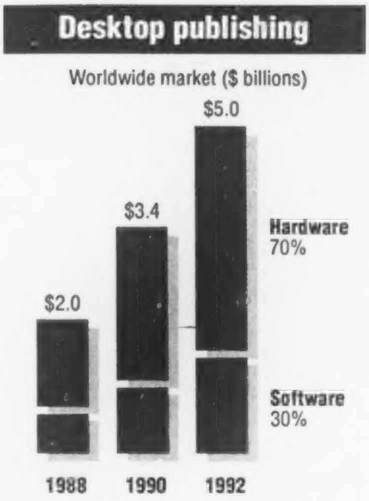
But Xerox and Aldus aren't worried. They argue that word-processing firms face formidable technical barriers in merging the disparate functions of text manipulation and page layout. For one thing, Grossman asserts, the file formats of word-processing packages are too restrictive. "Those formats are optimized for manipulating text, not for formatting it" to appear on a printed page, she says. "They are no competition for serious desktop publishing software."

Jill Bamburg, director of marketing for Aldus Corp. in Seattle, agrees. "I don't think [word-processing packages] can get to be true desktop publishing packages," she says. "Text entry and page composition are too different."

Lisa Wellman, a spokeswoman for Letraset (publisher of Ready,Set,Go!, a $495 package for the Macintosh), says desktop publishing software is headed toward more specialization, not broad general-use software such as enhanced word-processing programs.

Vendors insist that dedicated desktop publishers have an attractive future because they haven't really penetrated their existing markets yet. "Our primary market is the graphic arts community, and that has only been penetrated by 4% or 5%," according to Wellman.

"We have barely begun to touch the power users of desktop publishing, the people in corporations who do technical documentation for company products," concurs Grossman. Ventura Publisher's primary customers are small companies with annual revenue of less than $30 million. "Most are doing newsletters and brochures; some are doing manuals. A lot of them are doing hardware and software development," she says. "Major corporations are just starting" to use Ventura, according to Grossman, who predicts that in 1989, the mix of sales will shift in favor of large corporate customers.



Source: Creative Strategies

Xerox claims that Ventura Publisher, which sells for $895 in the IBM-compatible market (it isn't available on the Apple Macintosh), offers two distinct advantages that keep the company in a leadership role: speed and a technique for rapidly adding specific type styles to page layouts.

> **"There are too many competitors, and there probably will be some kind of a shakeout in the near term"**
>
> **Thad Webster of Hewlett-Packard**

Grossman says that Ventura computes page layouts at the relatively high rate of 20,000 characters per second. While Xerox considers Aldus its chief competitor, Grossman contends that Aldus' PageMaker is, by comparison, "painfully slow . . . but they have a powerful marketing organization that's keeping them afloat. In fact, they do very well."

Bamburg argues that PageMaker's speed "is entirely dependent on what you're trying to accomplish. For many users who are going from start to finish on a project, our product is faster than [Ventura]. . . . In general, the market considers our package to be easier to use than theirs." The MS/DOS version of PageMaker sells for $795 and the Macintosh version for $595.

Despite their disagreements, the two leading firms in desktop publishing software give the hardware vendors some of the credit for the rapid growth of their market. "Desktop publishing couldn't have come into existence without laser printers," says Grossman. "Today, the fact that there are more and better laser printers and color printers just fuels our business as we fuel theirs."

Decreasing hardware prices also are creating new opportunities for desktop publishing software vendors. "Now that schools and institutions can afford hard disk drives, a whole market segment is opening up," Grossman says. Adds Bamburg: "as 80286 and 80386 PCs come down in price it helps desktop publishing along."

Hardware market

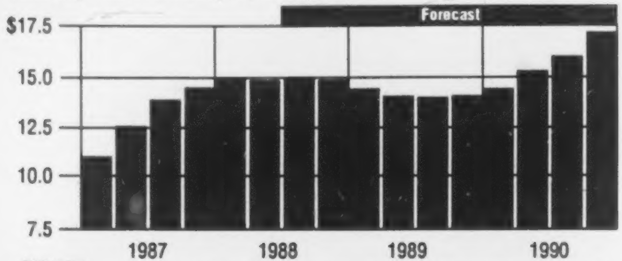
It's harder to identify the leaders in the hardware market, which is made up of a diverse set of manufacturers making laser printers, monitors, computers and accelerator boards. But companies like Hewlett-Packard Co., which makes laser printers at its facilities in Boise, Idaho, have seen the number of competitors skyrocket.

Thad Webster, product planning manager for Hewlett-Packard desktop publishing laser printers, which start at $2,695, says that "the visibility given to desktop publishing has helped to accelerate the number of vendors in the market with laser printers." Soon after HP introduced its first 300 dots-per-inch laser printer in 1984, there were between 10 and 20 competitors, he notes. Now there are nearly 50 competing firms.

While strong growth in desktop publishing laser printers is expected into the 1990s, Webster says he thinks that "there are too many competitors, and there probably will be some kind of a shakeout in the near term." Some vendors may avoid the appearance of a retreat by keeping a desktop publishing laser printer in their product lines while relying on other models to generate sales, he adds. ☐

Electronic components — New orders

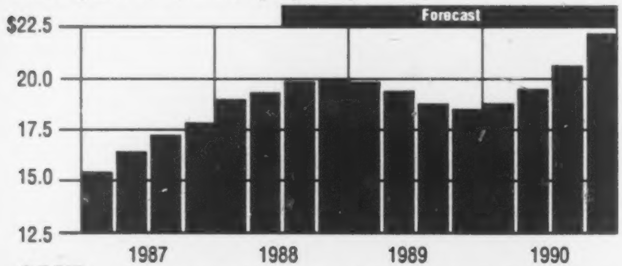
Quarterly totals, seasonally adjusted ($ billions)



SIC 367 Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Electronic components — Unfilled orders

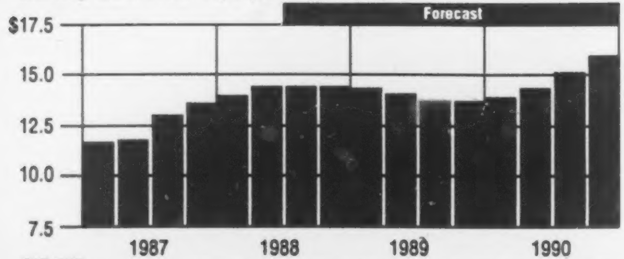
End-of-quarter totals, seasonally adjusted ($ billions)



SIC 367 Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Electronic components — Shipments

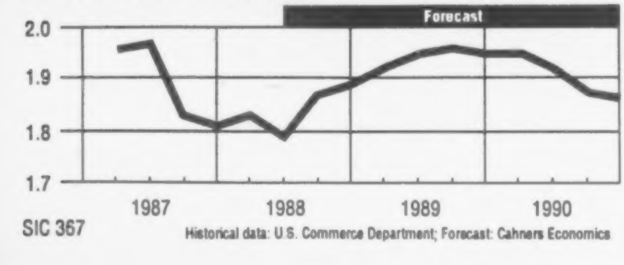
Quarterly totals, seasonally adjusted ($ billions)



SIC 367 Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Electronic components — Inventory-to-shipments

Quarterly averages, seasonally adjusted



SIC 367 Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Component makers put 1989 into perspective

After the disappointing ups and devastating downs of the past three and a half years, manufacturers of electronic components appear ready to panic at the slightest hint of bad news. Well, yes, the latest statistics do confirm that the U.S. components industry is heading down. The U.S. economy is probably not going to grow as strong in 1989 as it did in 1988. And, yes, that means capital investment will retrench and component demand will weaken.

But few economic forecasters expect 1989 to be a recession year, no matter which president is elected. Growth will slow down, not tumble down. That will set the stage for a muted business cycle in industrial markets. A panic mentality will hurt component makers in 1989, not help.

What do the latest statistics mean?

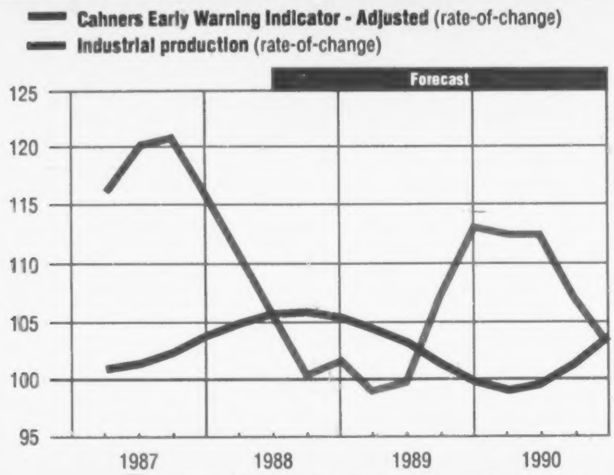
U.S. factories reported $14.8 billion worth of component bookings in the second quarter of 1988. This represented a 0.6% drop from the first quarter, the first quarterly decline since early 1987. Still, shipments of components totaled $14.5 billion, which was a 3.8% quarterly gain and a 23% year-ago gain. By the way, that year-ago increase was the best since November 1984.

The increase in shipments and slowing growth in billings is typical at the current stage of the business cycle. Growth in backlogs has begun to slow down and inventory growth has picked up.

All these statistics were expected. The lack of surprises means there will be no unexpected imbalances in the supply/demand conditions in the components industry. The coming slowdown will be very slow. For example, component shipments are expected to remain relatively level in the $14.5 billion range during the second half of 1988. That will mean a 14% overall increase in shipments in 1988, for a total of $57.3 billion. Then, in 1989, shipments will fall gradually to $13.7 billion in the fourth quarter. By the year's end, shipments will have fallen only a modest 3%. In 1990, shipments are expected to regain strength rapidly.

If the forecast has a risk, it's probably on the up-side. With inventories still so low, the industry may only experience a no-growth scenario next year. So, what's there to worry about? Sure, the industry will not see double-digit growth in 1989, but economic business cycles are a fact of business life. The fact for next year is that the business cycle won't drag the industry into a deep, dark recession; it will only cause a momentary pause in long-term growth.

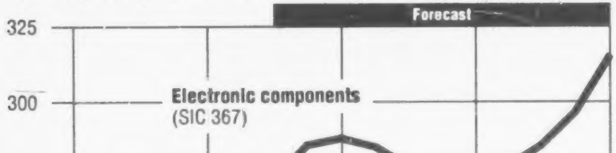
Economic indicators



Historical data: U.S. Federal Reserve Board; Forecast: Cahners Economics

Components and instruments — Industrial production

Industrial production indexes, seasonally adjusted quarterly averages, 1977 = 100



Historical data: U.S. Federal Reserve Board; Forecast: Cahners Economics

Higher inventories of imports may slow growth

The indicator peaked in the third quarter of 1987 and is heading for a low point in the second quarter of 1989. But the downturn will be mild and short-lived, according to the CEWI readings. The growth expected in U.S. industrial production has been revised downward slightly for 1988 by Cahners Economics. So, instead of slowly accelerating growth this year, industrial output will hover around the 5.1% to 5.9% range all year, before heading down in 1989. The reason for the revision? Inventories of imported goods are high. This could result in greater import price competition and U.S. manufacturers could feel the heat. Still, export growth and renewed business investment will steer U.S. industry to steady growth gains this year.

Instrument output continues to climb

Output from scientific and engineering instruments manufacturers continues to rise at an easy, steady pace. An ongoing stream of orders and relatively high levels of backlogs will continue to beef up production through the remainder of this year. Growth is expected to dwindle afterward as businesses pull back on their capital equipment purchases. However, the corporate push for increased efficiency and quality will most likely mean a greater share of investment spending on test, measurement and inspection equipment and process control instrumentation. Cahners Economics forecasts production increases of 6% in 1989 and 3% in 1990.

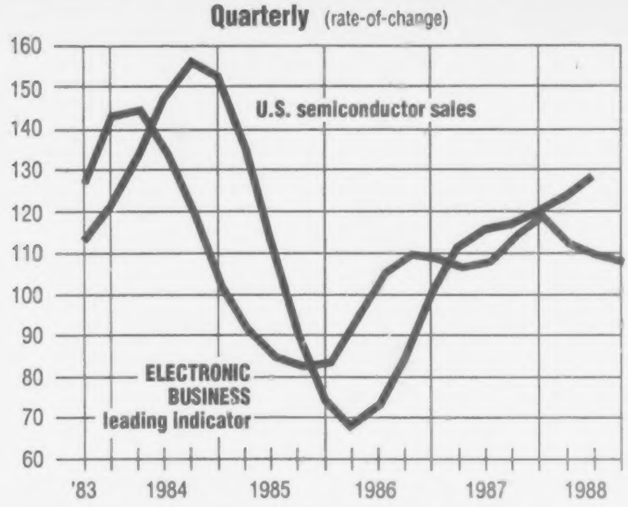
Business cycle caps components growth

Electronic components output at U.S. factories grew a modest 1.9% in the second quarter of 1988, according to the Federal Reserve Board. That pace was short of the projected 3.4% rate, which means inventories of components continue to be held at extremely low levels. Apparently, caution is the guiding principle for 1988 production schedules. Component output must pick up pace in the second half of 1988 in order to fulfill a projected 11% growth by the end of the year. A minor 0.2% decline is expected in 1989. But if production growth is slower this year, then expect a slight output increase next year. The forecast for 1990 is for more of the same: 6% growth in 1990 will mark the upswing in the next business cycle. Without a sharp downturn in 1989, production growth in 1990 will not see double digit gains.

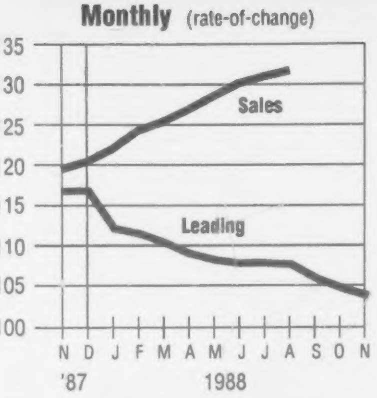
BUSINESS BAROMETER

FORECAST FOR ELECTRONICS, COMPUTERS AND SYSTEMS

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368



The ELECTRONIC BUSINESS leading indicator has barely budged in the last three months. But the plateau will yield to further downward drifting by this fall. Slowly and steadily, the mild downturn in the indicator presages a modest downturn in semiconductor sales in 1989.

Source: Cahners Economics

Electronics industry indicators this month

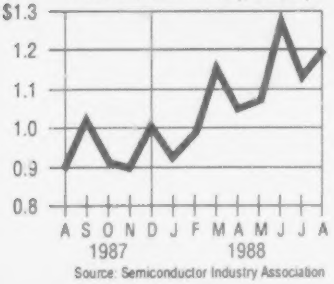
	Latest month	Previous month	Year ago	1987 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, July)	108.3	108.5	109.7	111.1
U.S. semiconductor bookings ($ millions, 3-month average, Aug.)	$1,209	$1,260	$964	$951
Weekly hours of semiconductor production workers (monthly average, July)	40.4	40.1	40.9	40.6
Electronic components leadtime index (1977 = 100, Sept.)	114.6	117.9	103.8	100.7
S&P's semiconductor stock price index (1970 =10, monthly average, Aug.)	54.1	61.1	77.9	65.5
Change in electronic components inventories ($ millions, SA, July)	+$145	+$88	+$32	+$41
Contract and orders for plant and equipment ($ billions, SA, July)	$39.7	$40.1	$37.5	$34.6

SA = seasonally adjusted, all other data is not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

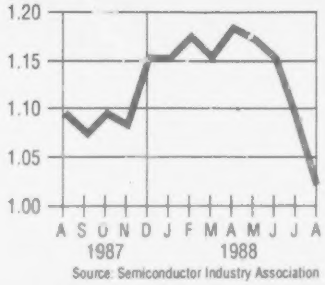
Semiconductor sales

North American market ($ billions)



Source: Semiconductor Industry Association

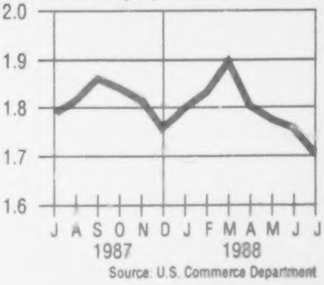
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted ratio



Source: U.S. Commerce Department

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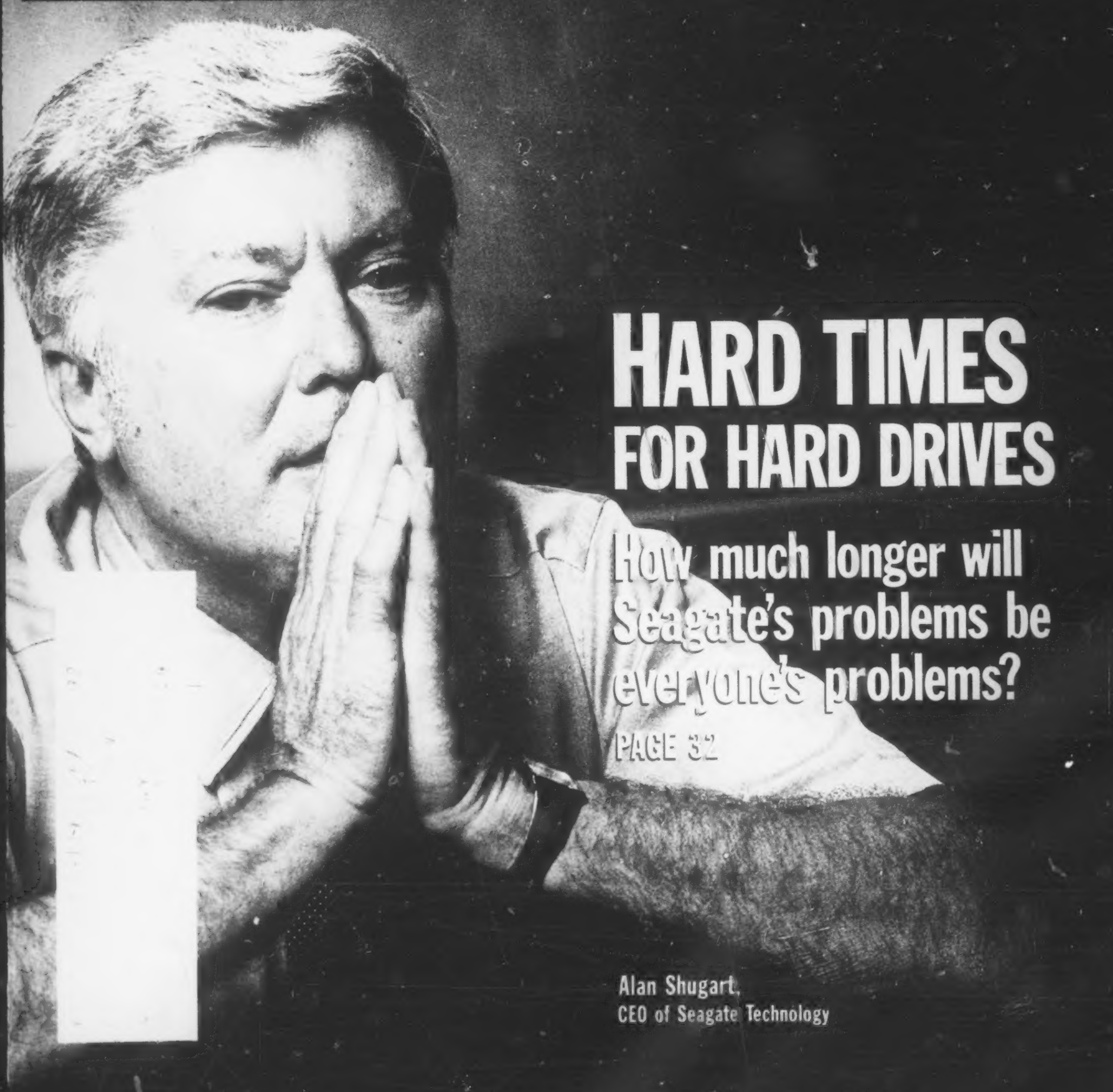
FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES—WORLDWIDE

NOVEMBER 15, 1988



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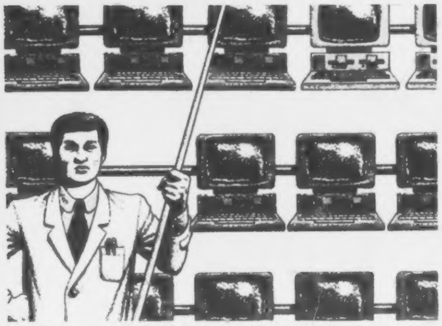

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INSIDE BUSINESS

Slipped disks

A decade ago, who'd have believed that the hard disk drive market would become the knee-in-the-groin, price-pricked commodity business it is today? And who'd have thought that Seagate Technology — former owner of two-thirds of the world's 5.25-inch hard disk drive production and longtime maker of magnificent profits — would be wading around in the red stuff?

Watching the frowns deepening not only in Scotts Valley but throughout the drive business, senior editor Alden Hayashi headed west to explore Seagate's problems, and to try to anticipate how much longer those difficulties would be shared by the rest of the industry.

He returned with a thorough analysis of an industry in turmoil, an industry which still finds it cannot gloat over the disk drive king's misfortunes. Seagate may hold prisoner "only" 55% of the 5.25-inch business these days, but that's plenty influential still. Just watch how Wall Street responds: when Seagate catches a stock-market cold, the entire industry sneezes.

But Alden found plenty of evidence to show that Seagate's grip may be loosening. Stuck with a vertically integrated structure it believes gives it quality, price and parts-sourcing advantages, the company may now be too earthbound to dash after fast-moving opportunity in 3.5-inch drives. And it may have misjudged an industry shift to OEM sales, where performance is valued as highly as price. What should computer makers, distributors, drive makers and VARs do next? Our cover story should help them decide.

Seagate sleuth Alden Hayashi

Forget profits?

Forget net income. Well, don't exactly forget it, but give it less status in the hierarchy of crucial financial measures. Today, reports contributing editor Ray Wise, return on investment (ROI) is the yardstick that investors increasingly prefer. Ray's article supports the "Top ROI performers" directory assembled by senior editor Linda Stallmann. Cray Research comes out tops: with an ROI last year of 20.2%, the supercomputer maker clearly has a management team that is deploying corporate assets and preserving shareholder values more efficiently than most

JOHN KERR, Managing editor

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Hard times for hard drives

Because of its sheer size, Seagate dominates the PC hard disk drive industry. But is that power waning?

BY ALDEN M. HAYASHI

These are tough times for Seagate Technology, the world's largest manufacturer of hard disk drives for personal computers.

After borrowing $290 million to expand manufacturing last year, the company was later forced to slash production by a third. Two hundred workers were axed from the Scotts Valley, Calif., headquarters last summer. And, on Oct. 25, Seagate announced it had lost a staggering $52.8 million during its Sept. quarter. The news stunned Wall St. analysts. This, after the company's stock price had plunged 50% since July.

Seagate's recent woes, however, have not given competitors cause for celebration. Instead, everyone is nervously awaiting the company's next moves. Like a wounded grizzly bear, Seagate is massive, powerful and dangerous; it could drag the entire industry down, fear pessimists. "Every time Seagate hiccups, you end up with perturbations everywhere," notes Kathy Braun, vice president and general manager of storage products for Western Digital Corp. of Irvine, Calif.

Stirring widespread anxiety is the possibility that Seagate might incite a price war that could engulf the industry. Furthermore, in the eyes of stock investors, Seagate's problems are the industry's problems. Consequently, when Seagate stumbles, it often touches off a chain reaction on Wall Street that winds up cheapening not only Seagate's stock, but competitors' stocks as well.

But Seagate's influence over the industry might be dwindling as the hard disk drive market undergoes some fundamental changes. Competitors assert that more and more sales are being made directly to computer manufacturers as opposed to distribution and dealer networks where Seagate — with its high-volume, low-cost manufacturing strategy — dominates. And others cite Seagate's slowness to tackle the fast-growing 3.5-inch drive sector as evidence of its waning power.

Not a one-quarter fix

What frightens many competitors today is Seagate's massive inventory problem. At the end of the company's fiscal year, ended this past June, total inventory had swelled to $365 million, a 169% increase over the previous year's figure. Meanwhile, the company's cash dropped from $396 million to $93 million. Referring to the situation, Alan F. Shugart, Seagate chairman and CEO, says, "It's not going to be a one-quarter fix. . . . Hopefully we can do it in two. But maybe it'll take three."

Excess inventory is only the tip of Seagate's iceberg. The company has more than a million square feet of manufacturing space that, if not kept busy, aggravates overhead costs. "We *have* to get our production rates back to where they were," declares Shugart. "We recently had to reduce our production rates, which increased our costs. That's what's hurting us."

Accordingly, Shugart says, "We're planning on selling 7 million disk drives this fiscal year." Last calendar year, Seagate made 3.5 million drives, accounting for roughly 34.9% of total worldwide production (including captive facilities), according to market research firm Dataquest Inc. of San Jose. Shugart is counting on the worldwide market growing 40% to 45% this fiscal year.

Still, even assuming such robust demand, trouble lies ahead, asserts Phil Devin, Dataquest analyst. Devin predicts the worldwide demand for small hard disk drives will reach roughly 14.7 million units this year. The industry, however, has the capacity to produce 17 million such drives. Meanwhile, any slowing of growth in the PC market would exacerbate matters. In fact, it could spell disaster for many disk drive makers, agree analysts. "The drive industry could actually be faced with major plant write-offs, semiconductor style," warns John T. Rossi, of Alex.

Liane Enkelis

Brown & Sons in San Francisco.

The implications are clear, especially for those familiar with Seagate's hardball tactics. "Sure I'm concerned about a price war," says an executive at Longmont, Colo., drive maker MiniScribe Corp. "Seagate doesn't care what happens to their short-term margins."

Shugart has done little to allay those fears. "Price wars don't bother me," he flatly states. Although Shugart refuses to divulge his pricing plans, he does say: "If we have inventory, we have to do something about it." He asserts that because of Seagate's high-volume, low-cost manufacturing, the company is well armored to withstand any pricing wars.

Inordinate clout

Indeed, Seagate's sheer size affords the company inordinate pricing clout. "When Seagate lowers its prices, we *have* to respond. After all, it is an elastic market," grumbles David Dury, president for Priam Corp., of San Jose.

Seagate, certainly, is no stranger to pricing skirmishes. According to various accounts, the company in the past slashed prices on half-height 20- and 30-megabyte 5.25-inch disk drives, forcing competitors out of those markets. Early last summer, the company did the same with 85MB 5.25-inch products, painfully lowering unit prices to $500, from the $600 to $700 range. "Seagate has been cutting prices like crazy, holding people's hands to the flier," notes Rossi of Alex. Brown & Sons.

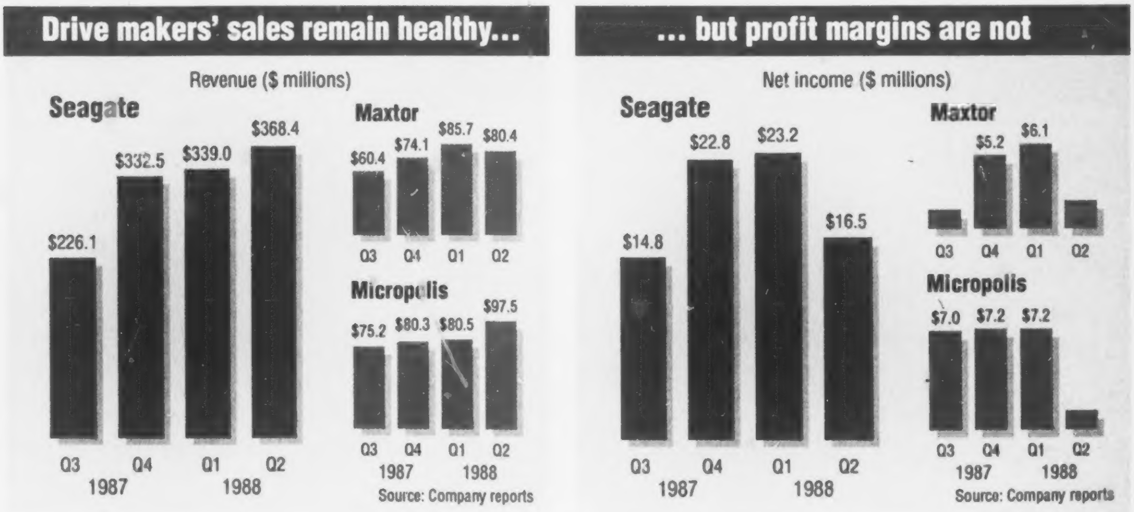
Already, the damage has been substantial. Of the flock of disk drive makers, one of the hardest hit was Maxtor Corp. of San Jose. "We did an analysis — taking the difference between our March and June prices — and that was essentially the entire cause of the decrease in our gross margins from about 29% to about 21%," asserts Maxtor president George M. Scalise. At MiniScribe, margins slid 5%. Micropolis Corp. of Chatsworth, Calif., blames the pricing scuffle for a drop in net income which, according to one Wall Street analyst, will plunge from $27 million last year to $14 million this year. Seagate itself has not been immune. The company's gross profit margin fell to 19% last fiscal year, from 29% the previous year.

Last year, Seagate made 3.5 million drives, or 34.9% of total worldwide production

Not surprisingly, competitors are avoiding head-on collisions with Seagate, particularly in the behemoth's hometown playing field, the so-called personal computer "aftermarket." In these market channels, instead of shipping disk drives to computer makers such as IBM and Apple Computer Inc., independent drive companies like Seagate sell their products elsewhere, generally to distributors and dealers who then combine the drives with PCs bought separately from the computer makers.

"If I was operating in that market right now, I would be very, very concerned. There's no doubt about it that Seagate's going to be calling the cadence on this one for quite awhile," says Timothy Mahoney, vice president for sales and marketing for drive maker Rodime Plc, headquartered in Scotland.

As a result, Micropolis, MiniScribe and Quantum Corp., among others, have turned their attention to selling disk drives directly to the computer makers, or OEMs, instead of through the aftermarket where distributors and dealers worship prices supreme. "We were forced to focus on OEM relationships," says David Brown, Quantum president. Adds Stuart P. Mabon, chairman and president of Micropolis, "We are no longer pursuing the 85MB 5.25-inch aftermarket. We decided that there wasn't any point in giving disk drives away." In



Drive makers' sales remain healthy...

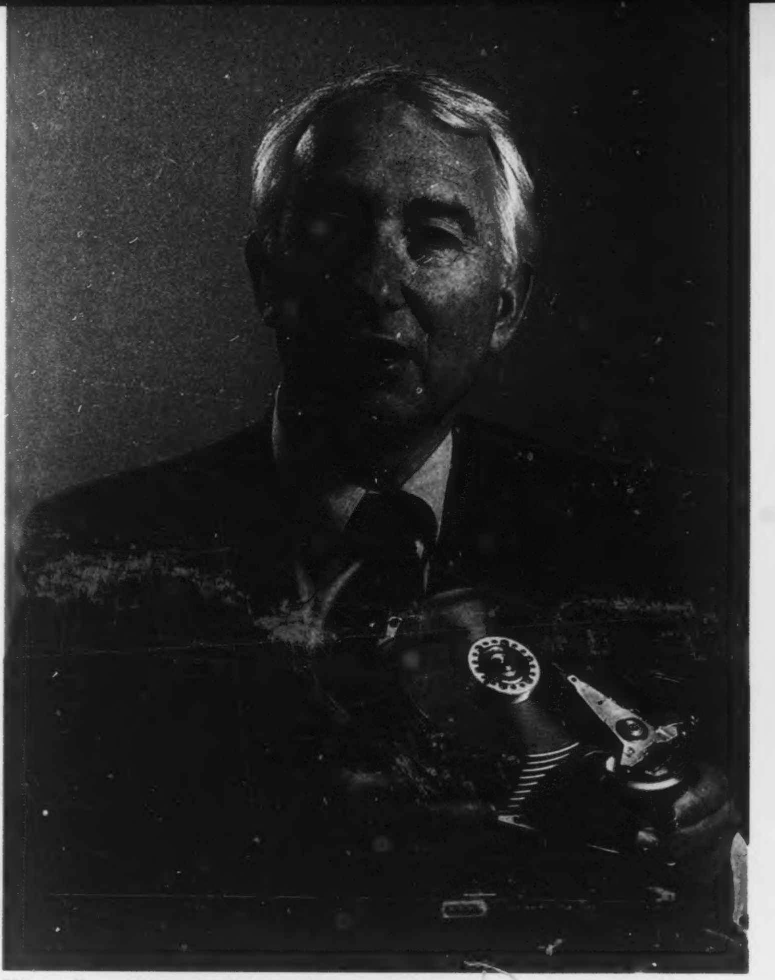
... but profit margins are not

Source: Company reports

Source: Company reports

Price skirmishes and overcapacities have already eroded the margins of some hard disk drive companies

fact, when asked how a company like Micropolis competes against a giant like Seagate, Mabon replies: "We now compete with Seagate in only 5% of our business. That's how we compete against Seagate."



Micropolis president Stu Mabon: "We now compete with Seagate in only 5% of our business. That's how we compete against Seagate"

Michael Grecco

A different ball game

Unlike the aftermarket, selling to OEMs is a whole different ball game, one in which Seagate may not be adequately equipped to compete, allege the company's critics. For starters, OEMs generally require state-of-the-art products, historically not one of Seagate's strengths. "Seagate tends to use yesterday's technology in huge volumes," says Micropolis' Mabon. "The OEM customer is not going to stay with you if you don't have a product that meets his requirements, no matter *what* you price it for," asserts Finis Conner, chairman and CEO of Conner Peripherals Inc. of San Jose.

So competitors have scampered upmarket to faster disk drives with smarter interfaces and higher capacities. In addition, most companies are focusing their efforts on making smaller drives using the newer 3.5-inch format.

But pricing wars, like brush fires, can often spread uncontrollably, engulfing territories far beyond their initial reach. "Seagate does establish a price-point reference that we have to recognize in the marketplace, because our customers recognize it," admits Priam's Dury. "You can't have a 50MB product selling for $500 and expect to sell a 100MB for $4,000. That's just too much more for the extra capacity." Maxtor's Scalise reports that the recent pricing pressure on 85MB 5.25-inch drives has affected practically his entire 5.25-inch line, including 760MB products. Western Digital's Braun says she is even expecting some price degradation in the low end of her 3.5-inch line.

Seagate's sins

Competitors also complain that Wall Street, which thinks of Seagate and the disk drive industry as being one and the same, tends to punish everyone for Seagate's sins. "That's the biggest effect on us by Seagate," declares Conner of Conner Peripherals, which made its debut on the stock market last April.

Conner and other industry executives complain that when Seagate's stock drops, so does theirs, regardless of how well they're doing. Last July 20, Seagate's stock tumbled 29.7% after the company released its quarterly results which disappointed Wall Street. For no apparent reason, Conner Peripherals' stock fell 6.5% that day. Maxtor's dropped 5.3% and both Micropolis and MiniScribe saw their stocks fall 4.8% [see chart].

Seagate's troubles can even overshadow a competitor's announcement of a plum contract. "I can't fathom how an analyst can write a glowing report on a new, leading-edge computer from a major computer manufacturer without looking back at who's supplying the key components and writing a consistent report on that," grouses Conner.

If Seagate's influence over the hard disk drive industry is strong today, it was almost monopolistic several years ago. In 1981, the company accounted for roughly two-thirds of the world's production of 5.25-inch drives, according to Disk/Trend Inc. of Mountain View, Calif. At that time, Seagate's strategies were closely scrutinized by competitors. "We all manufacture in the Far East now. We learned that lesson from Seagate," says Rodime's Mahoney. But Seagate no longer wields such power. The adjective "Seagate compatible," coined when the company established its ST506 5.25-inch disk drive as the industry standard years ago, is rarely used today.

A shrinking aftermarket?

Meanwhile, Seagate's slip, allege critics, was due to the company's failure to react quickly enough to marketplace changes. For starters, the aftermarket's relative size may be shrinking, assert some industry watchers. Five years ago, only one out of every four PCs shipped by OEMs had a hard disk drive already installed. At the same time, the other three had floppy drives which left a tremendous opportunity for distributors and dealers to add hard versions by buying them from independent manufacturers such as Seagate.

Today, however, computer OEMs are intent on grabbing the hard drive sales for themselves, contend analysts. IBM, for example, has announced that 90% of its new Personal System/2 computers will be shipped already equipped with a rigid drive, which will leave little opportunity in the aftermarket, asserts Dataquest's Devin. Consequently, Devin argues that disk drive makers must now deal directly with computer companies.

Shugart denies that such a fundamental change is occurring in the marketplace. According to him, two-thirds of Seagate's sales are still being made to the aftermarket. "It might bounce around a percentage point or two each quarter, but in general, it's stayed about the same," he insists. Dataquest's Devin predicts the aftermarket will shrink from 47% of the total 5.25-inch market this year, to 32% in 1992.

Seagate doesn't have the right products to compete for OEM contracts, claims Conner of Conner Peripherals, where virtually all sales are to OEM customers. "Ninety percent of Seagate's shipments are in older technologies," he scoffs. Apparently, Conner Peripherals' products — fast 3.5-inch drives — are the right ones: thanks to a major contract from Compaq Computer Corp., which also invested in the start-up, first-year sales at Conner Peripherals rocketed past $100 million.

"The major issue right now is what Seagate can do with 3.5-inch drives because the industry is heading in that direction," says Rossi of Alex. Brown & Sons. Dataquest's Devin asserts that 3.5-inch drives will account for 54% of the 14.7 million units made this year. Seagate, however, had only shipped 207,000 such drives, less than 10% of the company's total production, during the first half of 1988, admits Shugart.

"Seagate is at least a year behind in making the transfer to 3.5-inch drives," asserts Bob Katzive, analyst for Disk/Trend. A common criticism fired against Seagate is that the company's delay in ramping up 3.5-inch drive production resulted in missed sales targets. Not true, contends Shugart. Referring to the June quarter when Seagate's financials began faltering, he says, "We were not supply constrained on our 3.5-inch drives. We were demand constrained."

Some say Seagate may be at least a year behind in switching to 3.5-inch drives

Rodime's Mahoney gives his explanation of the apparent discrepancy: "Seagate wasn't supply constrained because they had the wrong products." Mahoney insists that the market wants faster drives with smarter interfaces. "The fact that Seagate can build a drive cheaper than anybody in the world doesn't mean anything if it's the wrong drive," he asserts.

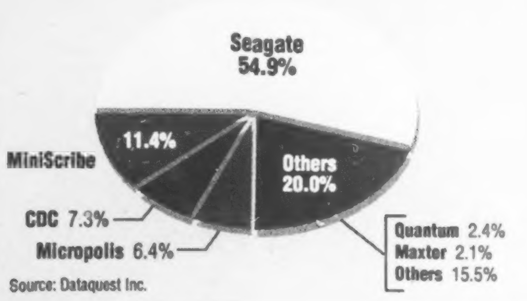
Upgrading its drive technology will prove a daunting task for Seagate because of the company's manufacturing emphasis on vertical integration. Years ago, Seagate decided to make practically every disk drive part by itself, including thin-film disks, recording heads, drive motors and semiconductors. The company did so in order to assure itself of an adequate supply of parts. Because of Seagate's huge production volumes, the strategy made sense. And vertical integration worked well in the distributor and dealer aftermarket, where product lifespans were long.

However, in the OEM marketplace, where product designs come and go like Gucci fashions, vertical integration suddenly becomes a disadvantage, assert critics. "Vertical integration, if not a practical barrier, is an emotional one to rapid product transitions because if you bring out a new product that obsoletes your old one, it requires a whole new capital structure," says Conner, who speaks from experience. Before founding Conner Peripherals, Conner was vice chairman for Seagate and also served a short stint at drive firm Computer Memories Inc., now headquartered in Far Hills, N.J. Adds Quantum's Brown: "Because Seagate ends up having to redesign all of the components, vertical integration could become the company's albatross."

Be that as it may, Seagate is not nearly as vertically integrated as outsiders think, counters Gunter Heine, general manager of the company's motor division. "We buy more motors and disks than we make," he as-

While Seagate dominates the market for 5.25-inch drives...

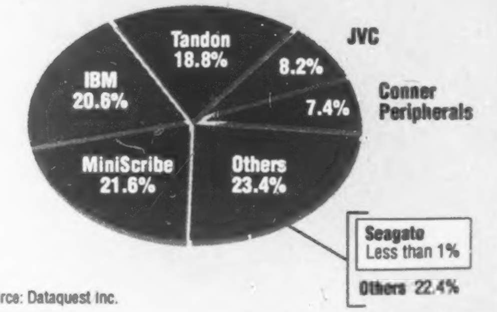
Total 1987 market: 6.4 million units



Source: Dataquest Inc.

... the company has been slow to establish itself in the 3.5-inch arena

Total 1987 market: 3.6 million units



Source: Dataquest Inc.

Seagate is not nearly as vertically integrated as outsiders think, says Gunter Heine, general manager of the company's motor division.

Liane Enkelis

serts. In fact, Heine says Seagate makes less than 10% of the electronic components it needs.

Don't count on IBM

Seagate doesn't have forever to establish itself in the 3.5-inch market. Already 80% of the major OEM contracts for such drives have been locked up, asserts one source who claims that of the major U.S. PC manufacturers, only Wyse Technology of San Jose is open game.

AST Research Inc., Compaq and Zenith Electronics Corp. have chosen 3.5-inch drives from Conner Peripherals. Apple recently awarded Quantum with a contract for 40MB and 80MB 3.5-inchers. A subsidiary of N.V. Philips GL has chosen Rodime. Tandy Corp. decided to go with two suppliers, neither of which appears to be Seagate. Furthermore, IBM, which used to account for more than 50% of Seagate's sales, seems to have turned completely in house. This year, Big Blue will make more than 2 million 3.5-inch units in its Japanese facility, according to a Dataquest estimate.

And, as in any market that undergoes a fundamental shift in technology, a window has opened for new competitors. At least four California start-ups — Areal Technology Inc. of Santa Clara, Cardiff Peripherals Corp. of Carlsbad, Comport Corp. of Milpitas, and Kalok Corp. of Sunnyvale — have recently entered the marketplace. Three of the companies did so through manufacturing agreements with Korean partners.

Still, all is not lost for Seagate. "There's a new machine being designed in every one of these computer OEMs every day of the week, so the game is never won or lost. It's a continuing war, forever and ever," notes Western Digital's Braun. To be sure, Seagate is preparing itself for the next battle. "They've got some pretty spectacular 3.5-inch products in development," says Dataquest's Devin.

And Seagate shows no signs of backing down. After investing $300 million in capital expenditures last fiscal year, the company is planning to spend $150 million more this year. Given its fragile financial health, Seagate may have to fall further in debt. The company already issued $287 million of convertible debentures last year. "We have several lines of credit and we may have to expand those lines," says Shugart.

As Seagate goes...

Stock prices

	July 19, 1988	July 20, 1988	Percentage change
Seagate	18 1/2	13	-29.7%
Conner Peripherals	9 5/8	9	-6.5%
Maxtor	9 1/2	9	-5.3%
Micropolis	15 1/2	14 3/4	-4.8%
MiniScribe	12 7/8	12 1/4	-4.8%
Priam	1 5/8	1 3/4	+7.7%
Quantum	11	10 1/2	-4.5%

Source: NASDAQ

Last July 20, Seagate announced disappointing financial results for the June quarter, and the company's stock tumbled 29.7%. Apparently, the bad news also affected the stock prices of several competitors

A go-for-broke style

The son of a conservative structural engineer, Shugart nonetheless has a definite go-for-broke management style. "Shugart looks, acts, and thinks like a wildcatter," says Rossi of Alex. Brown & Sons. "But if Shugart had been conservative, Seagate would be, at this point, just a $400 million company instead of the $1 billion company that it is."

Indeed, thanks to Shugart and David T. Mitchell, Seagate president and COO, sales skyrocketed from $215 million in fiscal 1985 to $1,265 million just three years later. Executive salaries have also soared. Last year, Shugart and Mitchell, along with Douglas K. Mahon, Seagate senior vice president, were among the electronics industry's top 10 highest-paid executives [ELECTRONIC BUSINESS Oct. 15, p74]. Each of the trio's salaries cleared the $1 million mark last year.

To justify those salaries, management will have to effect some major changes if Seagate is to succeed in the growing OEM marketplace, contend analysts. In addition to developing more innovative products, the company must become quicker and nimbler to keep up with the scorching pace set by OEM customers like Compaq. Says Quantum's Brown: "Seagate will have to become more like us, than us like Seagate."

Still, no one is dismissing the disk drive king yet. In fact, competitors are quick to express equal parts of both respect and fear for Seagate's resilient management. Indeed, only the impudent have forgotten how quickly the company resurrected itself after the PC market crashed in 1984. Even when sales plummeted from $344 million in fiscal 1984 to $215 million one year later, Shugart and Mitchell managed to maintain Seagate's profitability. Meanwhile, several other disk drive makers were wallowing in the red. Says Rodime's Mahoney: "How can you count Seagate out? My God, anybody who does is not being very smart." ☐

Since Black Monday, the spotlight's been on ROI

Suddenly, investors are concerned. And when Wall Street talks, everyone listens. High-technology firms like Cray and Compaq are focusing on ROI and ROE as well

BY RAY WISE

Generating high rates of return on investment can help a technology company keep growing and enhance the attractiveness of its shares, especially in a nervous stock market. And since October of 1987, the market has been nervous indeed. So, while investor concern over return on investment and equity appeared minimal during Wall Street's "trip to the moon on gossamer wings," these traditional measures have become increasingly important since that trip's disastrous end on Black Monday. "Investors are paying a lot more attention to such fundamentals as ROI and ROE," reports Rich Spillane, who runs the Fidelity Select Portfolio in Boston.

Last year, U.S. industry averaged a 10% return on investment. Even in technology, where returns tend to be above average, 20% is considered high. Yet, Minneapolis-based Cray Research Inc. produced an ROI of 20.2% in 1987 and 21.7% the previous year. Meanwhile, Compaq Computer Corp., with headquarters in Houston, last year boosted ROI to 24.8% from the year-earlier 16.7% and expects another 20%-plus performance this year. And Western Digital Corp., Irvine, Calif., attained a 20.3% ROI in 1987, a quantum leap from the year-earlier 13%. And leading software companies' ROIs hover around 30%.

A variety of factors can contribute to increased ROI. Finely honed forecasting techniques and careful capital marketing financing certainly help. Moreover, Cray is an example of one of the most important factors in keeping ROI high: product differentiation.

"Cray is the highest of high technology," says Warren K. Greene, president of the American Investors group of mutual funds in Greenwich, Conn. "Once you have reached that level, it is hard for anybody, even the Japanese, to catch you. Cray is in a world of its own."

While Cray's chief financial officer, John F. Carlson, does not shrug off the competition so readily, he generally agrees with Greene's assessment. "We are a single-product company with a clear vision," Carlson says. "Our products help customers do things they could not otherwise do. And to continue that product dominance, we spend 15% of revenues on research and development."

Product superiority can push up ROI because profitability reflects price, and price is driven by the product. Cray's supercomputers can simulate the effect of a wind tunnel in the design of an aircraft; test the durability of an auto without smashing it into a brick wall; and help oil companies find and recover petroleum deposits with maximum efficiency. Until now, it's been difficult for customers to find a cheaper model. Consequently, Cray has two-thirds of the worldwide supercomputer market, including an awesome 80% outside Japan. And the firm's machines fetch $2.5 million to $20 million each.

More than ever before, though, Cray is facing competition. In Japan, Hitachi Ltd. and NEC Corp. are making supercomputers, and Fujitsu Ltd. is also having a go at it. IBM would like to enter the market, Carlson says, but probably not the high end, which is Cray's exclusive turf. But Cray wants more volume in the middle because, according to Carlson, "it is questionable how much more the top end can grow."

Another company benefiting from a high degree of product differentiation is Compaq Computer Corp, mainstay of the portable computer business and a big player in the IBM-compatible desktop market. Long term, company officials say, returns should be boosted even higher than the current high rates by a recently unveiled product at the high

ROI leader Cray Research Inc.'s CFO John Carlson: "We are a single product company with a clear vision"

Alvis Upitis

end of the desktop computer line.

Compaq's high returns are the result of sound growth management, according to Daryl J. White, corporate controller. And that in turn, he says, is at least partially due to the company's deft timing of capital financings. Unless this cycle is finely tuned, a company can wind up with overcapitalization and excess capacity, or undercapitalization and too little capacity. Complicating matters are the vagaries of the capital markets and the necessity of responding swiftly when a market window opens.

Encountering a window in the bond market last spring, Compaq sold $200 million of 6.25% convertible debentures, raising its long-term debt to a highly respectable 25% of total capitalization. The capital structure of an average manufacturing company is 50% equity, 50% debt. Debt is cheaper than equity, says White, "and so you waste corporate resources by expanding with equity capital alone."

Compaq's growth has been dizzying recently, with 1988 sales expected to surge nearly 60% to $1.9 billion from last year's $1.2 billion — and this can cause problems. "When you are growing at such a rapid pace, in general, selling and administrative expenses can accelerate extremely fast," says White.

Another strong advocate of finely honed forecasting is Bert Moyer, CFO of Western Digital, whose sales of board-level subsystems and other products soared 66% last year and should jump a similar amount in 1988. "You have to forecast where your business is going," Moyer urges. "We like to keep our expansion a little short of our expectations." Moyer says some CFOs, to their eventual sorrow, seek to keep slightly ahead of demand. But then "only slightly" turns into "more than slightly."

Exacerbating this is the rapidly changing technology of the capital equipment itself and the corporate love affair with staying on the leading edge of manufacturing know-how. "We tend to get wrapped up in our own technology," says Moyer, who stresses that attainment of maximum manufacturing efficiency can be an outright error, depending on whether the corporate strategy is to achieve cost leadership, product differentiation or market focus.

"Only when you seek cost leadership does it make sense to try to keep on the leading edge of manufacturing cost control," Moyer advises. According to this view, a product differentiation company like Cray or Compaq, or a market-focus enterprise like Sun Microsystems Inc., which concentrates intensely on the engineering marketplace, does not need to invest heavily in production cost control.

As a product's sales volume expands, a shift from product differentation to a cost-leadership strategy may be called for, according to Moyer. "When the market for a product enlarges substantially, competition is attracted and cost becomes a factor.

Compaq's controller Daryl White: Look for the open window in the capital markets

Moyer cites Western Digital's entry into the manufacture of video graphics components. To attain market penetration for the line, the company adopted a product differentiation approach. As volume expanded, Western Digital invested heavily in manufacturing capability to drive prices down and competitors out. As a result, Western Digital now has a huge 65% share of the $400 million market for video graphics components.

In part, returns on investment and equity reflect the corporate asset base, which determines the size of the denominators in the ratios. All other things being equal, it would be unreasonable to expect an integrated steel company to generate returns as high as a consulting firm or advertising agency. Return on investment (ROI) measures how efficiently management uses corporate assets and how well it preserves shareholder values. It is the ratio of net earnings to the total capital employed in the business, often consisting of both debt and equity. In the absence of long-term debt, ROI equals return on equity (ROE).

Viewed as a manufacturing company, Apple Computer Inc. would inspire awe for its 26% return on investment last year and its prospects for topping 30% in 1988. But, in fact, Apple farms out so much of its manufacturing that it qualifies as an organization of product designers. It does however, invest in people, rather than plant and equipment, with the emphasis on sales representatives and customer engineers. "We have 100 such people today and would like to have 200," says Deborah Coleman, Apple's CFO. Apple has advanced from selling just boxes to selling marketing solutions to customer problems, a transformation that mandates expansion of the field force.

If Apple is people-oriented, the software industry is even more so. "Our capital requirements are far different from those of a hardware company," says Jeffrey L. Walker, senior vice president and chief financial officer of Oracle Systems Corp. "We invest in people rather than in plants. Essentially, we have no capital requirements."

Lotus Development Corp. employs 2,400, more than 70% of them professionals, and keeping the workforce satisfied is a major corporate priority, as evidenced by annual employee opinion surveys that sound out attitudes toward management. Lotus also makes a point of determining the needs and problems of its customers. Major clients, for example, are brought into corporate headquarters in Cambridge, Mass., for executive briefings. "It seems to work," according to Martin Fahey, director of investor relations. "We've sold 4 million spreadsheets and they are being used by 7 million to 8 million people."

There is a limit to how much a software firm can reinvest in itself by hiring people, says CFO Frank Gaudette of Microsoft Corp., "because people can be absorbed only so fast. However, we are in a growth mode and we are hiring." ☐

Top ROI performers in U.S. electronics

Rank	Company	Return on investment 1987	Return on investment 1986	Return on equity 1987	Return on equity 1986	Fiscal 1987 sales ($ millions)	Fiscal 1987 profits ($ millions)	Fiscal year ended
1	**Lotus Development**	30.0%	32.8%	35.7%	42.1%	$395.6	$72.0	12/87
2	**Oracle Systems**	29.3%	16.1%	31.9%	18.9%	282.1	42.9	5/88
3	**Microsoft**	29.2%	28.2%	30.1%	28.2%	345.9	71.9	6/87
4	**Apple Computer**	26.0%	5.7%	26.0%	5.7%	2,661.1	217.5	9/87
5	**Compaq Computer**	24.8%	16.7%	34.1%	23.4%	1,224.1	136.3	12/87
6	**Ashton-Tate**	23.0%	22.9%	24.1%	24.6%	267.3	43.1	1/88
7	**Seagate Technology**	21.3%	15.4%	39.5%	16.6%	958.1	139.7	6/87
8	**Western Digital**	20.3%	13.0%	21.2%	22.8%	462.5	42.8	6/87
9	**Cray Research**	20.2%	21.7%	24.1%	28.2%	687.3	147.1	12/87
10	**Inmac**	20.0%	19.8%	22.9%	34.8%	165.4	7.7	7/87
11	**ADC Telecommunications**	19.3%	18.7%	20.1%	19.8%	166.9	15.3	10/87
12	**Medtronic**	19.0%	17.4%	21.9%	19.1%	653.3	86.5	4/88
13	**NCR**	17.7%	13.0%	19.4%	14.0%	5,640.7	419.3	12/87
14	**MAI Basic Four**	17.6%	15.9%	29.3%	31.4%	321.0	22.8	9/87
15	**Stratus Computer**	17.6%	16.3%	18.9%	17.9%	184.2	19.4	12/87
16	**DEC**	17.3%	10.1%	18.1%	10.8%	9,389.4	1,137.4	6/87
17	**Digital Communications**	17.2%	17.3%	17.2%	17.3%	181.4	27.0	6/87
18	**Computer Associates**	16.4%	9.2%	20.4%	14.5%	709.1	101.8	3/88
19	**Intelligent Systems**	16.4%	0.1%	24.7%	0.1%	163.2	10.2	12/87
20	**AMP**	16.3%	12.4%	18.5%	14.5%	2,317.8	249.7	12/87
21	**Gerber Scientific**	15.6%	11.7%	17.5%	13.1%	264.0	29.6	4/88
22	**Amdahl**	15.4%	5.7%	18.5%	7.9%	1,505.2	142.0	12/87
23	**Tandy**	15.3%	11.8%	17.6%	15.1%	3,452.2	242.3	6/87
24	**Measurex**	15.2%	13.3%	15.8%	13.9%	227.4	26.8	11/87
25	**Tandon**	15.2%	-101.4%	18.3%	122.7%	289.1	17.1	12/87
26	**Logicon**	15.0%	10.5%	15.0%	10.5%	218.9	9.1	3/88
27	**Tandem Computers**	14.4%	11.7%	14.6%	11.9%	1,035.5	105.6	9/87
28	**Atari**	14.2%	23.3%	26.3%	23.8%	493.2	44.2	12/87
29	**3Com**	14.0%	12.9%	14.4%	13.2%	251.9	22.5	5/38
30	**MiniScribe**	14.0%	22.3%	27.8%	30.6%	362.5	28.1	12/87
31	**Pitney Bowes**	13.5%	14.3%	19.2%	18.2%	2,250.5	199.4	12/87
32	**Molex**	13.3%	12.0%	13.7%	12.6%	386.8	43.4	6/87
33	**AST Research**	13.1%	31.0%	13.1%	31.4%	206.0	13.0	6/87
34	**Micropolis**	12.7%	16.5%	19.6%	16.5%	288.3	27.2	12/87
35	**Intergraph**	12.2%	13.7%	12.3%	14.2%	641.1	69.9	12/87
36	**Dynatech**	12.1%	14.1%	16.1%	19.2%	367.8	24.5	3/88
37	**Diasonics**	12.1%	-18.8%	14.4%	-22.7%	267.6	15.2	12/87
38	**Watkins-Johnson**	12.0%	13.3%	14.7%	16.8%	264.3	17.1	12/87
39	**IBM**	12.0%	12.0%	13.7%	13.9%	54,217.0	5,258.0	12/87
40	**E-Systems**	11.8%	13.8%	14.1%	16.3%	1,227.2	60.4	12/87
41	**Scientific-Atlanta**	11.6%	-4.3%	12.0%	-5.1%	495.3	24.3	6/87
42	**Marshall Industries**	11.4%	4.7%	15.8%	8.4%	420.4	17.6	5/88
43	**Aydin**	11.1%	10.7%	12.6%	11.6%	149.2	8.8	12/87
44	**Hewlett-Packard**	10.6%	10.9%	12.8%	11.8%	8,090.0	644.0	10/87
45	**Mentor Graphics**	10.5%	6.2%	10.8%	7.1%	221.8	20.3	12/87
46	**Diebold**	10.3%	10.6%	10.5%	10.9%	439.1	35.8	12/87
47	**Ultimate**	10.0%	14.5%	12.6%	15.5%	209.2	13.0	4/88
48	**Wyse Technology**	9.9%	10.2%	17.0%	19.6%	456.6	28.0	3/88
49	**Texas Instruments**	9.2%	2.0%	11.4%	2.3%	5,594.5	256.9	12/87
50	**Applied Magnetics**	9.2%	4.0%	9.5%	4.1%	211.9	14.2	9/87

(Continued)

Top ROI performers in U.S. electronics

Rank	Company	Return on investment 1987	Return on investment 1986	Return on equity 1987	Return on equity 1986	Fiscal 1987 sales ($ millions)	Fiscal 1987 profits ($ millions)	Fiscal year ended
51	**General Instrument**	9.1%	2.8%	12.0%	4.0%	$1,155.5	$66.2	2/88
52	**Dynascan**	9.1%	8.2%	14.5%	16.2%	191.6	6.6	12/87
53	**Sun Microsystems**	9.0%	9.4%	15.1%	11.0%	537.5	36.3	6/87
54	**Unisys**	8.7%	-0.7%	12.7%	-1.1%	9,712.9	578.0	12/87
55	**Intel**	8.5%	-10.9%	13.4%	-14.4%	1,907.1	175.5	12/87
56	**Motorola**	8.3%	5.7%	10.2%	7.0%	6,707.0	308.0	12/87
57	**Computer Consoles**	8.1%	-2.6%	29.9%	-23.1%	148.4	9.6	12/87
58	**Avantek**	7.5%	10.9%	7.5%	10.9%	213.7	11.6	12/87
59	**Xerox**	7.5%	6.8%	10.4%	9.5%	10,320.0	578.0	12/87
60	**Genicom**	7.5%	12.9%	21.5%	18.9%	302.2	12.6	12/87
61	**Harris**	7.4%	5.4%	8.6%	6.6%	2,079.0	84.5	6/87
62	**Altos Computer Systems**	7.4%	18.7%	9.1%	19.8%	153.9	9.7	6/87
63	**Loral**	7.0%	5.1%	17.0%	15.8%	1,440.8	74.3	3/88
64	**Honeywell**	7.0%	0.4%	11.3%	0.6%	6,679.3	253.7	12/87
65	**Anthem Electronics**	6.7%	7.5%	7.3%	7.5%	196.9	5.0	12/87
66	**GM Hughes Electronics**	6.7%	6.1%	7.4%	6.7%	10,481.0	521.1	12/87
67	**Cherry Electrical**	6.6%	2.8%	10.4%	4.4%	194.6	7.4	2/88
68	**Apollo Computer**	6.3%	3.0%	9.6%	4.9%	553.7	21.7	12/87
69	**CTS**	6.3%	-16.0%	8.3%	-22.8%	261.1	10.5	12/87
70	**Veeco Instruments**	6.2%	0.3%	9.2%	0.4%	195.6	9.2	9/87
71	**Prime Computer**	6.1%	10.3%	12.9%	10.7%	960.9	64.8	12/87
72	**Maxtor**	6.0%	9.8%	11.9%	20.4%	271.2	14.1	3/88
73	**National Semiconductor**	5.9%	-2.5%	6.2%	-2.8%	2,469.7	62.7	5/88
74	**Pioneer-Standard Electronics**	5.8%	2.2%	15.4%	6.3%	254.6	5.2	3/88
75	**Analog Devices**	5.6%	7.6%	6.1%	8.7%	370.4	18.7	10/87
76	**Recognition Equipment**	5.6%	6.0%	8.4%	9.1%	264.7	11.2	10/87
77	**ISC Systems**	5.4%	12.0%	6.5%	14.7%	168.5	6.5	6/87
78	**Litton Industries**	5.3%	2.8%	13.1%	7.0%	4,419.7	138.1	7/87
79	**Micom Systems**	5.3%	1.4%	5.6%	1.5%	223.4	9.8	3/88
80	**DSC Communications**	5.1%	3.3%	6.9%	5.5%	312.4	14.6	12/87
81	**SCI Systems**	5.0%	7.0%	12.0%	12.0%	552.9	16.0	6/87
82	**Augat**	4.8%	-3.6%	5.4%	-4.4%	313.2	11.5	12/87
83	**AVX**	4.8%	-1.5%	8.5%	-2.0%	271.9	15.8	12/87
84	**Oak Industries**	4.8%	-30.6%	7.2%	-50.7%	182.2	5.7	12/87
85	**Wyle Laboratories**	4.3%	4.8%	6.5%	5.3%	368.0	5.8	1/88
86	**Cubic**	4.1%	0.7%	7.1%	1.0%	361.8	7.9	9/87
87	**Varian Associates**	4.1%	-3.0%	4.9%	-3.6%	982.8	21.4	9/87
88	**BRIntec**	4.0%	8.6%	10.0%	21.5%	293.7	5.9	12/87
89	**VLSI Technology**	3.4%	0.0%	5.7%	0.0%	172.0	8.1	12/87
90	**Mark IV Industries**	3.1%	3.9%	18.4%	25.3%	403.0	17.0	2/88
91	**Wang Laboratories**	3.1%	2.3%	4.8%	3.5%	2,836.7	70.7	6/87
92	**Cipher Data Products**	3.1%	5.4%	3.1%	5.4%	178.2	4.3	6/87
93	**Gould**	3.0%	3.6%	5.2%	6.2%	933.4	25.0	12/87
94	**Avnet**	2.6%	3.1%	3.5%	3.7%	1,547.1	22.8	6/87
95	**Sun Electric**	2.5%	3.4%	4.1%	27.5%	203.9	3.3	10/87
96	**Andrew**	2.2%	5.7%	2.5%	6.6%	223.2	3.8	9/87
97	**LSI Logic**	2.2%	1.1%	3.5%	1.5%	262.1	10.7	12/87
98	**John Fluke**	1.7%	8.5%	1.9%	9.8%	206.3	2.0	9/87
99	**Control Data**	1.7%	-20.0%	2.4%	-31.0%	3,366.5	25.0	12/87
100	**Singer**	1.5%	6.2%	3.7%	9.6%	1,902.7	23.4	12/87

Source: ELECTRONIC BUSINESS

Why defense firms fret over the Pentagon's computer R&D

DOD budget cuts and DARPA's new passion for pure research may mean that the Strategic Computing Program lacks the commercial punch it once promised

BY DWIGHT B. DAVIS

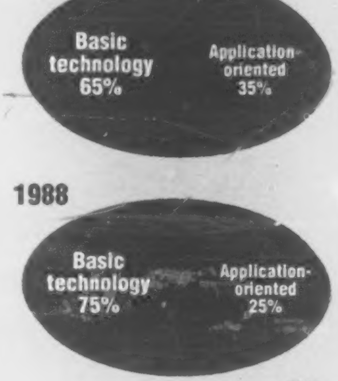
Five years ago last month, the Pentagon's Defense Advanced Research Projects Agency (DARPA) embarked on a 10-year program intended to revolutionize computer technologies ranging from microelectronics to artificial intelligence to system architectures. The initiative was dubbed the Strategic Computing Program, or SCP, and enthusiastic backers predicted it would generate technologies with vast commercial as well as military potential. In fact, given its subject scope and anticipated funding of $600 million over its first five years, many believed the SCP would serve as America's answer to Japan's then-new Fifth-Generation Computer Project.

Now at its midpoint, the SCP has already spawned a number of commercial products and advanced many computer and electronics technologies. But many of its early goals — criticized by some as unrealistic from the start — have been scaled back or eliminated. Meanwhile, beset by congressional cutbacks, the program disbursed just $326 million in contract funds to university and industry researchers through fiscal year 1987. So now, defense-electronics firms are worrying that the program may not produce for them the great gains it once promised.

However, those who pin high hopes on the DARPA computing program do so with some historical justification. Since it was established in 1958 and charged with the fostering and management of advanced research projects assigned by the Secretary of Defense, DARPA has been arguably the nation's most successful research agency. An early focus on space science and technology soon broadened to encompass strategic and tactical weapons development, nuclear test verification techniques, basic sciences research, and information-processing technology.

In the last two categories, DARPA funding and supervision was instrumental in the development of gallium arsenide (GaAs) microcircuitry, VLSI chips, computer time-sharing and interactive computer graphics. The agency-funded Arpanet became the world's first widespread packet-switched network, and served a key role in the collaborative development of other computer and communications technologies by linking dispersed researchers around the country. DARPA was the first significant backer of the fledgling field of artificial intelligence in the late 1950s, and its involvement in computer architectures runs the gamut from the Illiac IV, the first parallel-processing supercomputer, to today's frontier research in neural network designs.

DARPA funding breakdown



Source: DARPA

DARPA clearly favors the "R" in R&D

Warm reception

Little wonder then, that many in 1983 greeted the SCP with less-than-guarded optimism. In the electronics and defense industries, the reception was especially warm. Not only would SCP contractors win sizable grants to perform the necessary R&D, but virtually all of the targeted technologies lent themselves to "dual use"; that is, they held potential for commercial as well as military application. And, since virtually all of the SCP activities are nonclassified, companies performing work under the program are under no constraints when it comes to applying the DARPA research to marketplace products.

In some cases, SCP funds have been directed even at existing commercial development projects in an attempt to stimulate the production of products that DARPA deems relevant to its objectives. Such was the case with the agency's backing of Thinking Machines Corp. in its development of the Connection Machine, a parallel processor with as many as 64,000 processing units. "DARPA essentially bought the first machine in advance," explains John Mucci, vice president for sales and marketing at Cambridge, Massachusetts-based Thinking Machines.

Since Thinking Machines delivered the first CM/1 model to DARPA in November 1985, the company has shipped 12 to 15 million-dollar-plus CM/1s to other buyers and has sold several dozen of its second-generation CM/2 parallel processors, Mucci says. And while the company obviously benefited from using DARPA funding to help bankroll its product development, DARPA as well as Thinking Machines benefits if the product does well in the marketplace

Earl Keleny

because success attracts software and support more easily than would a special-purpose machine, Mucci argues.

For its part, DARPA has always walked a tightrope between sticking to the military ramifications of its programs on one side and proclaiming the benefits of the commercial spin-offs on the other. With the SCP, both aspects were stressed from the start.

On the military side, the SCP broke from traditional DARPA strategy, which usually established a clear gap between the basic research that the agency funded and the eventual application of the research in military systems. With the SCP, DARPA initially set up as goals three prototype military systems — the driverless "autonomous land vehicle"; a "pilot's associate," which would assist the decision-making of military airmen; and a naval battle management system — that would serve as demonstration testbeds for the basic technologies being developed. By establishing such well-defined application goals, the agency hoped to direct better the basic research and to help "pull" it toward timely completion.

The agency later added three more target applications in smart weapons, air/land battle management, and radar imagery analysis. SCP funding was split, with approximately 65% of the budget going to "technology base" contracts in AI, multiprocessor architectures, microelectronics, and software; and 35% devoted to integrating these technologies into the military system prototypes.

Big promises

Despite this unusual — for DARPA — establishment of clear military applications as part of the SCP, the agency recognized the value of commercial spin-offs both to corporate contractors and to congressional funding sources. The 1983 SCP prospectus stated: "The Strategic Computing Program promises the production of machine intelligence technology that will enable yet another major cycle of new economic activity in the computer and electronics industry. . . . Spin-offs from a successful Strategic Computing Program will surge into our industrial community."

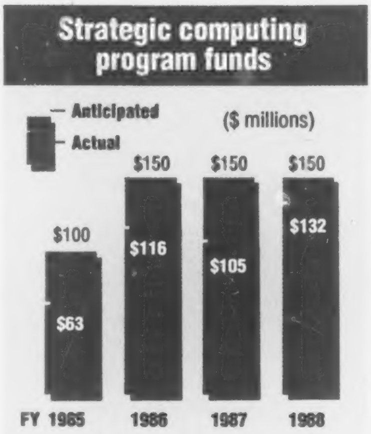
The breadth of the SCP funding across the electronics industry gives some credence to these early claims. To achieve high speeds, tight packaging, and radiation resistance in microcircuitry, DARPA let contracts to Honeywell Inc. to develop hybrid optical and switched bus interconnects; to McDonnell Douglas Corp. for a GaAs pilot line; to Rockwell International Corp. for optoelectronic interconnects, optical crossbar switches, and GaAs multifunction arrays; to Westinghouse Electric Corp. for a GaAs-on-sapphire program; to Sparta Inc. for a photorefractive memory system; and to Cyberoptics for multiple frequency striping.

In machine architectures, DARPA has funded a number of multiprocessor design projects, in part to hedge its bets among several competing configurations. These have included Thinking Machine's Connection Machine; Bolt Beranek and Newman Inc.'s Butterfly; General Electric Co.'s WARP processor; IBM's RP-3 architecture; and the DADO/DSP processor from AT&T's Technologies operation. The SCP also bankrolled Texas Instruments Inc.'s development of its Compact LISP machine.

Running on top of this hardware will be an array of AI technologies. Computer vision systems are required by the autonomous land vehicle and smart weapons programs and will have broader application in photo interpretation and robotic manipulation roles. Work in this discipline includes obstacle avoidance and path planning at the Hughes Research Laboratory of GM Hughes Electronics; spatial representation and modeling at SRI International; and vision modeling at GE.

Meanwhile, speech processing and natural language understanding have direct application to both the battle management programs and to the pilot's associate system. Here, Bolt Beranek is researching advanced continuous speech and language understanding; TI is developing a speech database; SRI is investigating the processing of written discourse as well as speaker independence; and Dragon Systems is working on the problem of interpreting speech in real time.

Finally, in the area of knowledge-based systems, two of the leading commercial AI vendors, Teknowledge Inc. and IntelliCorp Inc., have been working under SCP contracts to develop the programming environments and tools necessary to create the expert systems that will reside at the heart of each prototype application.



Does not include $50 million in annual funds for DARPA's non-SCP computer research

Source: DARPA

DARPA hasn't gotten as much computer-research money as it hoped for

While it's inevitable that these SCP projects and others like them will continue to alter the complexion of the information-processing marketplace, it's no longer clear that the impact will be as strong and as pervasive as once expected. Part of the reason for this uncertainty is the natural consequence of budget cutting. When funding drops from an anticipated $150 million for the year to an actual $105 million, as happened in fiscal 1987, a consequent reduction in program influence is unavoidable.

It's the combination of these cuts with a shift in DARPA's emphasis that has some contractors especially worried. The first phase of project funding established set timetables to demonstrate technological advances within the context of the application prototypes. But DARPA's current management team has deemphasized the integration of the technologies in the prototypes, according to some contractors, preferring to focus more on the independent development of the basic technologies themselves.

The consequences of this shift, including its impact on the speed with which the research can be commercialized, are debated even among contractors working under the same prototype projects. In the autonomous land vehicle (ALV) program, for example, researchers are split in their opinions of the importance of the changes.

Martin Marietta Corp. has served from the start as the company charged with integrating the various ALV technologies into a functioning vehicle prototype. The company is working under a $22 million SCP contract due to expire in 1990, although ALV program manager Robert Douglass admits future budget cuts may reduce the amount actually spent. Through 1987, the prototype ALV had met functional milestones that included an on-road

DARPA: Commitment remains strong

Despite some researchers' opinions to the contrary, the person responsible for administering the Strategic Computing Program maintains there has been no slippage in either the program's ultimate objectives or in DARPA's commitment to supporting fundamental SCP technologies. Budget cuts "have forced us to be more frugal," says Jack Schwartz, director of DARPA's Information Science and Technology Office, "but we're still following the program's goals pretty well."

In any case, Schwartz says, progress in some SCP disciplines is more "idea constrained" than funding limited. "Doubling the money in certain areas of basic research won't help, because progress is dependent upon someone having a 'Eureka!' type of insight," he says. Schwartz places certain fields of artificial intelligence, including natural language processing, among those disciplines still waiting on conceptual breakthroughs.

Some development programs such as those in VLSI and parallel processing clearly have benefited from the infusion of SCP funds, according to Schwartz. In parallel processing, advances have occurred more rapidly than even the SCP's ambitious goals anticipated. "Strategic Computing funding definitely pulled this country ahead of the foreign competition in this field, which is nice for a change," he says.

Schwartz disagrees with critics who say DARPA has universally backed off from the SCP's application goals and is no longer funding the transition of research into integrated systems. Although funding of applications research has fallen from approximately one-third to about one-quarter or one-fifth of the overall SCP budget, the effect of this shift has been felt more strongly in some programs than in others. The autonomous land vehicle project, after successfully meeting its first phase application goals, has seen cutbacks in its second phase. But he cites the pilot's associate program as one that remains quite active in its pursuit of long-standing application goals. ☐

4.5- to 5-kilometer run averaging 14 km/hr and a top speed of 20 to 22 km/hr.

The project's second phase, initiated in March of this year, shifted the emphasis to off-road navigation, where speeds of 3 km/hr have been achieved. But, "phase II is not so concerned with achieving fixed performance milestones," Douglass says.

Douglass attributes the change to a different philosophy among the DARPA managers now directing the SCP. In part, he says, "There was a feeling that the naming of specific performance goals was not appropriate to a research and development program, since it sometimes amounted to the scheduling of research breakthroughs."

In addition, the ALV's ambitious 10-year goals were viewed by many outside observers as unattainable. The ALV, according to the SCP prospectus, "must plan routes using digital terrain and environmental data, devise strategies for avoiding unanticipated obstacles, estimate the vehicle's position from landmark and other data, update the on-board digital terrain database, generate moment-to-moment steering and speed commands, and monitor vehicle performance and on-board systems," all while traveling off-road at speeds of up to 60 km/hr.

Hughes Research Laboratory has several SCP contracts, including two under the ALV program being pursued by the lab's Artificial Intelligence Center. One, the development of an off-road, real-time planning and navigation system, was a $1.6 million contract due to expire this fall. The second is a $1.9 million contract that runs through next March and encompasses the use of computer vision to identify and avoid obstacles and assist in path planning. "We are being directly affected by the changes in the SCP program," says David Y. Tseng, manager of the AI Center, "and we don't anticipate any follow-ons to current contracts."

Too goal-oriented?

While Tseng agrees that the SCP "was too goal- and breakthrough-oriented," he thinks the deemphasis on goals has hurt the program. "When doing research, one needs to find out early on if the research is working and how the fundamental components will fit into an integrated system. The strength of application goals was that they allowed us to measure how our basic research applied to realistic situations."

A sampling of electronics firms with large Strategic Computing contracts

Company	($ millions) Total SCP awards to date
Bolt Beranek and Newman	$31.7
Martin Marietta	21.1
Texas Instruments	21.1
Rockwell International	15.1
Thinking Machines	12.8
Hughes Research Labs	11.4
General Electric	6.2
Teknowledge	5.8
Lockheed Electric	4.0
Honeywell	3.8
AT&T Technologies	3.3

Source: DARPA

The loss of this goal-driven orientation will have ramifications into how quickly the ALV research will appear in nonmilitary systems, Tseng believes. For example, Hughes sees potential applications of the vision and navigation technologies in autonomous factory vehicles as well as in underseas research probes.

But "there is a huge gap between the publishing of research papers and the building of system prototypes," Tseng says. And because the SCP is no longer providing the bridge between these two stages, "the speed with which spin-offs occur and with which the technologies move into users' hands will really be affected," he warns.

> **"Without DARPA funds, AI wouldn't be where it is today"**
>
> — **Frank Kuo of SRI International**

Others are less pessimistic about the effect of the SCP program changes. "The program is every bit as strong as it always was," says Frank Kuo, associate director and senior science advisor at SRI International's Computer and Information Sciences division. Any problems that may exist "are not due to a lack of direction at DARPA, but to a lack of available funds," according to Kuo.

SRI is working under several AI-related contracts in computer vision, speech processing and natural language processing. The nonprofit contract research house holds the patent rights to any of its developments and, although SRI focuses more on fundamental research than on technology commercialization, Kuo notes that the company is free to license any of its patents to outside firms. "Without DARPA funding, AI wouldn't be anywhere near where it is today," Kuo says.

Doubts

Others hope such optimism bears out. One is David J. Mishelevich, vice president and general manager of IntelliCorp's Applications and Research division. But he has his doubts: "There are significant AI cutbacks in the DARPA budget, which is reason for concern," he says. IntelliCorp is now in the second phase of a four-year, $2.8 million contract to develop expert system development tools. Advances made under the contract's first phase were quickly incorporated in the company's Knowledge Engineering Environment system, of which approximately 2,100 copies have shipped.

Now DARPA is emphasizing software engineering more than basic AI research, according to Mishelevich, and he worries about the consequences. Although IntelliCorp and its competitors will continue their own in-house research on product development, SCP funds or not, the commercial AI shops won't pursue as broad an agenda as they might with continued DARPA support. "There are a lot of research areas out of the commercial mainstream that we can't afford to follow on our own," Mishelevich says, "and the diminishing role of DARPA in the field will hurt AI's prospects."

Whatever is concluded about DARPA's role, SCP backers can already point to a number of influential commercial successes. As Thinking Machine's Mucci says, "People will look back in several years and will credit DARPA with sharing the pride of authorship for a fundamental change in the way in which computing is done." ☐

Issues for the '90s: Reliability and support

The push to submicron geometries may be putting a financial strain on equipment suppliers, making it harder for start-ups to compete

BY MARK MEHLER

It's that time again — time to begin the arduous shift to the next generation of higher-speed, higher-density circuits. The goal: high yields on 4-megabit memories, microprocessors, ASICs, and other parts with feature sizes of 0.8 to 1 micron, or roughly one-tenth the width of a human hair. The current generation of advanced circuits is fabricated with 1.25- to 1.5-micron lines.

Past technology shifts have been painful, and ramping up 0.8-micron volume production promises to be difficult, as well. Although manufacturers of wafer fabrication equipment and their customers have made incredible strides in developing workable submicron processes, several key problems have yet to be adequately addressed. Equipment reliability, particulate contamination, software integration and vendor staying power are among the sticking points. And this is true for almost every type of machine used in the wafer fabrication process — in exposing and etching wafers, implanting dopants, depositing metal and performing other complex production functions.

"The current generation of equipment is very capable of doing submicron work," argues Daniel Hutcheson, vice president of VLSI Research Inc., which estimates that $3 billion of the $4 billion in worldwide wafer fabrication equipment shipped in 1988 was ultimately purchased for submicron requirements.

"Optical steppers, for example, can take you down to 0.3 micron with excimer lasers. You can etch submicron lines with low-pressure plasma etchers and the new chemical vapor deposition (CVD) systems can deposit metal in those narrow, deep steps," notes Hutcheson. "But too few U.S. equipment suppliers are focusing on reliability, whether the machines work well over time, and how well they're supported and serviced. And not enough vendors are focusing on eliminating defects, of which 80% are caused by equipment. At 0.8 micron, defects are killers."

If you add the costs of designing and building in reliability and eliminating particulates to the already awesome costs of building a machine that can do the process, the total development cost on a new-generation system can run anywhere from five to 15 times the selling price. And these are $500,000 to $2 million systems. The demands of the submicron world are going to drive undercapitalized suppliers out of the market.

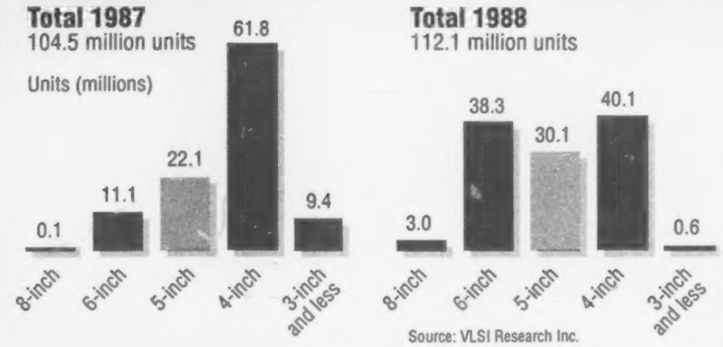
Fragmentation

Vendors and users confirm that semiconductor companies this year are more reluctant than ever to deal with venture-funded start-ups. Not only are IC makers concerned about lack of development capital, but they are afraid that venture capitalists might pull the plug in the absence of a vital new issues equity market. IBM, according to several sources, has taken a particularly hard line, backing out of dealings with little equipment companies.

"I fear that the fragmentation of . . . the domestic equipment industry is too great and our own entrepreneurs may not be able to afford development," lamented AT&T Microelectronics president William Warwick, in his keynote speech at last September's Semicon East show in Boston.

Peter Hanley, vice president of Applied Materials Inc.'s Etch Products division, agrees. "No way can a customer rely on a $10 million supplier anymore. They'll tell you, "We don't want to be 25% of your business." Reliability is a function of religiously gathering data and doing failure analysis. How can you do that effectively without a big enough installed

Worldwide wafer consumption



Source: VLSI Research Inc.

The push toward 8-inch wafers may be slower than once predicted, but it will add to the call for more reliable IC production gear

base at one customer to avoid customer-to-customer site variations? You've got to have size and [financial] strength to be a player at the 4- and 16-megabit levels."

AT&T's Warwick sees heavy consolidation, through mergers, strategic alliances and partnerships, as essential to the survival of the semiconductor equipment industry. Such action may already be underway.

William Reed, executive director of Semiconductor Equipment & Materials International, the industry's trade group, says membership, after growing from 800 in 1984 to 1,150 companies in 1987, has leveled off to about 1,200 companies in the past 12 months, reflecting some acquisitions, start-up fatalities, and a generally more realistic appraisal of entrepreneurial prospects.

For those still-breathing start-ups which have based their business plans on selling advanced equipment for submicron wafer fabrication, 1988 is a watershed. SiScan Systems Inc., a Campbell, Calif., company, has been hanging by its fingernails waiting for users to begin purchasing its laser-based linewidth measurement system. The company has sold about 30 systems in 2 years, but its market window was pushed back by performance gains in conventional optical microscopes. Senior vice president for marketing Barry Gottlieb says the company still believes that it has the only linewidth measurement tool that will do the job at 0.5 to 0.8 micron, but now is the time to convince major customers.

"We're at the crossroads," he insists. "Customers over the past few months have started to staff new fabs that will eventually [produce] 0.8-micron devices. We can offer enabling technology, but we have to beat down the industry's resistance to change, its fear of moving into new ground [with a start-up]."

Among the larger equipment vendors, progress is being made on a number of fronts. Closer working relationships with the advanced development teams of their customers are making for better targeted products. Applied's Hanley says gone forever are the days when an equipment supplier could afford the standard four-

Relax. Next year may not be "déjà vu all over again"

Fueled by a booming computer market and semiconductor makers' demand for advanced submicron technology, the IC equipment industry rebounded strongly in 1988, after a three-year slide.

VLSI Research Inc., a San Jose market analysis firm, projects total worldwide equipment sales — wafer fabrication, test, and assembly gear — will be $7.5 billion this year, up 39% over 1987. VLSI's Daniel Hutcheson adds, however, that this preliminary 1988 forecast is being upgraded, and could wind up as high as $8.6 billion, or 60% above last year. Equipment makers report backlogs of six months or more and deliveries stretching out to the third quarter of 1989.

Skeptics may note certain similarities to the "feeding frenzy" of 1984, when equipment makers reveled in new business, only to find many of those orders canceled and many of the delivered machines sitting uncrated in customer warehouses for two years. Some are inclined to cite the immortal words of Baseball Hall of Famer Yogi Berra: "It seems like déjà vu all over again."

Not so fast with those analogies, say other market observers. The semiconductor and IC equipment industries have changed greatly in the past four years. For example, notes Hutcheson, systems houses' chip inventories, which reached 22 weeks back in 1984, peaked at only nine weeks in this year's second quarter, suggesting that end users have a better handle on their needs and are successfully implementing just-in-time type programs. Semiconductor manufacturers, for their part, are less inclined to stack devices against speculative forecasts.

Meanwhile, equipment makers are not simply cranking out everything they can lay their hands on, as they did in 1984. Martin Hammond, marketing vice president of Gemini Research, a manufacturer of epitaxial process equipment which was recently acquired by another equipment supplier, Lam Research Corp., says he is keeping a very close eye on the long-term (shipment) trend line. If Gemini's order rates get too far above that line, says Hammond, the business plan is reevaluated and those orders are revalidated. Some orders don't even get booked at all.

Both the semiconductor and IC equipment industries have changed greatly within the past four years

"We remember four years ago," he says. "We monitor our parts inventory levels more closely and we're watching like hell for obsolescence. On orders, we get one-third [of the money] down. Our business is big-ticket items, $500,000 to $1.5 million apiece. The total market is only 50 to 80 units a year. In other words, in this kind of business, you'd better be realistic about your forecast and keep the right [parts] mix on your shelf."

Other reasons why déjà vu is not repeating itself include merchant semiconductor makers' concern over future interest rates and their success in driving to 100% utilization of their old capacity. Equipment suppliers such as George Rutland, president of Ultratech Stepper, which manufactures wafer exposure machines, say the big volume buys by the likes of National Semiconductor Corp. and Intel Corp. will wait until those customers have fully assessed demand for their product portfolios.

"We haven't seen the merchants make major shifts in capacity yet," he says. "Mainly, they're buying new advanced technology and our [low-end] replacement business is a little stronger . . . but our customers are pressing the limits [of current capacity] now. Look for the big players to begin a real ramp-up fairly soon." ☐

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THE ASIAN WALL STREET JOURNAL, MONDAY, APRIL 25, 1988

U.S., China Magazine

Special to THE ASIAN WALL STREET JOURNAL

NEWTON, Massachusetts – Cahners Publishing Co. said it will jointly publish a quarterly high-tech business magazine in China, beginning in March 1989, with the Technology Information Research Institute, a division of the Chinese Ministry of Electronics Industry.

Cahners, the publishing unit of Reed International PLC of London, said the magazine, "Electronic Business, Chinese Edition," will be the first Chinese-language business magazine aimed exclusively at managers of computer and electronics companies in China.

Articles will be excerpted from Electronic Business, a twice-monthly trade magazine Cahners publishes in the U.S. The magazine will not be sold on newsstands, but will be sent free to Chinese managers who are deemed qualified to receive it by the ministry.

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Cahners Publishing Company, Cahners Building, 275 Washington St., Newton, MA 02158

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or five-year development cycle.

"You've got be able to roll out a new machine in 18 months, to match the design cycles of [the customer]," he says. "You do that by designing in costs and reliability, and working in partnership with customers at the earliest stage to develop new processes."

Service issues

Vendors are also giving needed attention to reliability, service and support. Jerry Adomshick, customer support and technical services manager for Varian Semiconductor Equipment Group's Extrion division, a maker of ion implanters, says reliability and quality were two major factors in the "beating we took during the last recession . . . not necessarily that we had big problems, but users perceived us that way."

Varian, says Adomshick, responded in the past 12 months with new modular designs for easier preventive maintenance; and the formation of a customer support group designed "not just to go in when the machine's broken, but to make sure it is continually running."

Service contracts between user and vendor are becoming increasingly common in the IC industry, and some device makers, including AT&T, now run cooperative programs which penalize suppliers for poor uptime performance and offer financial incentives for meeting equipment utilization guarantees.

Yet another key issue at 0.8 micron is implementation of the Semi Equipment Communications Standard (SECS) for automating the IC factory. Users are pushing equipment vendors to help design and integrate new software that will finally allow machines to communicate on the shop floor, for collection and analysis of data and real-time process control. The equipment makers are not overly excited about the project.

"It's important that we make gains in automated control and reliability and issues like that," concludes John Birchak, a senior systems engineer at Intel Corp. "We have a two- or three-year window before we hit the next process bump at the 0.5-micron level, and if we don't solve the communications problems soon and ensure accurate, repeatable results, when the next fork in the road appears, it'll be too late." ☐

U.S. directory of plant sites and facilities

A company's offices and factories, like its cash and production machinery, are assets to be deployed as resourcefully as possible. The decisions on how best to utilize those resources are decisions for senior management.

Those decisions frequently come down to where new facilities should be located — necessary if a vendor's major market shifts geographically; if key personnel are concentrated elsewhere; if a merger forces reexamination of where the new headquarters might be; if a company is expanding enough to need new facilities; or simply if a lease is expiring.

But the decisions can't be made without the knowledge of what different regions have to offer. To make that information easier to obtain, ELECTRONIC BUSINESS once a year publishes this comprehensive directory of plant sites in the U.S.

NORTHEAST

CONNECTICUT

Contact: Mark Feinberg

Agency: Connecticut Department of Economic Development, 210 Washington Street, Hartford, Conn. 06106

Phone: (203) 566-5546

MAINE

Agency: State Development Agency, 193 State Street, Augusta, Maine 04333

Phone: (207) 289-2656

MASSACHUSETTS

Contact: Warren Dillon

Agency: S.I.T.E. Program, Department of Commerce and Development, Leverett Saltonstall Building, Government Center, 100 Cambridge Street, Boston, Mass. 02202

Phone: (617) 727-3215

Business conditions

Total electronics workforce 120,300
Average hourly wage (production line) $9.72
Average annual salary for electrical engineers . . . . $26,700-$40,000
Number of colleges offering advanced degrees in electrical engineering, computer science and related subjects 41

NEW HAMPSHIRE

Contact: William G. Herman

Agency: Office of Industrial Development, P.O. Box 856, Concord, N.H. 03301

Phone: (603) 271-2591

Business conditions

Total electronics workforce 25,052
Average hourly wage (production line) $10.45

Photography: Renee Fraser

Average hourly wage (clerical) $7.51
Average annual salary for electrical engineers $22,000

NEW JERSEY

Contact: George Nagle

Agency: Office of Economic Research, New Jersey Department of Commerce and Economic Development, 20 West State Street, P.O. Box CN823, Trenton, N.J. 08625

Phone: (609) 292-2423

Business conditions

Total electronics workforce 181,510
Average hourly wage (production line) $11.33
Average hourly wage (clerical) $6.50
Average annual salary for electrical engineers $46,500
Number of colleges offering advanced degrees in electrical engineering, computer science and related subjects 4

NEW YORK

Contact: Raymond G. Paolino

Agency: New York Sate Department of Economic Development, One Commerce Plaza, Albany, N.Y. 12245

Phone: (518) 474-8670

Business conditions

Total electronics workforce 147,600
Average hourly wage (production line) $10.35
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects . 93

PENNSYLVANIA

Contact: Jack Coma

Agency: Pennsylvania Department of Commerce, Bureau of Economic Research and Legislative Analysis, Room 469, Forum Building, Harrisburg, Pa. 17120

Phone: (717) 787-4088

Business conditions

Total electronics workforce . . . 100,000+
Average hourly wage (production line) $10.17
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects . 41

RHODE ISLAND

Contact: Kenneth Willette

Agency: Rhode Island Department of Economic Development, 7 Jackson Walkway, Providence, R.I. 02903

Phone: (401) 277-2601

Business conditions

Total electronics workforce (manufacturing) 20,000
Average hourly wage (production line) $8.25
Average hourly wage (clerical) $6
Average annual salary for electrical engineers $40,000
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects . . 2

VERMONT

Contact: Fred Newhall

Agency: Vermont Economic Development Department, 109 State Street, Montpelier, Vt. 05465

Phone: (802) 828-3221

Business conditions

Total electronics workforce 12,100
Average hourly wage (production line) $6.22
Average hourly wage (clerical) $5.68
Average annual salary for electrical engineers $34,000
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects . . 1

ATLANTIC

DELAWARE

Contact: Jane Robinson

Agency: Delaware Development Office, 99 Kings Highway, P.O. Box 1401, Dover, Del. 19903

Phone: (302) 736-4271

FLORIDA

Contact: Steve Mayberry

Agency: Florida Department of Commerce, Division of Economic Development, 501B Collins Building, 101 East Gaines Street, Tallahassee, Fla. 32399-2000

Phone: (904) 488-6300

Business conditions

Total electronics workforce	76,451
Average hourly wage (production line)	$4.35
Average hourly wage (clerical)	$4.87
Average annual salary for electrical engineers	$24,100
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects	8

GEORGIA

Contact: Pepe Cummings

Agency: Department of Industry and Trade, 230 Peachtree Street, Suite 700, Atlanta, Ga. 30303

Phone: (404) 656-3545 or (404) 656-7795

Business conditions

Total electronics workforce (manufacturing)	31,922
Average hourly wage (production line)	$8.34
Average hourly wage (clerical)	$6.92
Average annual salary for electrical engineers	$41,000
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects	1

MARYLAND

Contact: Jim Pifer

Agency: Office of Business and Industrial Development, Department of Economic and Community Development, 217 East Redwood Street, 10th floor, Baltimore, Md. 21202

Phone: (301) 333-6985

NORTH CAROLINA

Contact: Earle L. Bradley

Agency: North Carolina Department of Commerce, 430 N. Salisbury Street, Raleigh, N.C. 27611

Phone: (919) 733-4094

Business conditions

Total electronics workforce	60,000
Average hourly wage (production line)	$9.39
Average hourly wage (clerical)	$7.23
Average annual salary for electrical engineers	$29,000
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects	5

SOUTH CAROLINA

Contact: Sena H. Black

Agency: South Carolina State Development Board, Research and Information Resources, 1201 Main Street, Columbia, S.C. 29202

Phone: (803) 737-0400

Business conditions

Total electronics workforce	49,200
Average hourly wage (production line)	$8.30
Average hourly wage (clerical)	$6.84
Average annual salary of electrical engineers	$28,000-$45,000
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects	2

VIRGINIA

Contact: Hugh D. Keogh

Agency: Virginia Department of Economic Development, 1000 Washington Building, Richmond, Va. 23219

Phone: (804) 786-3791

WEST VIRGINIA

Contact: Sammi Baronner

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Phone: (304) 348-0400

Business conditions

Total electronics workforce	2,700
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects	1

SOUTH

ALABAMA

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Contact: Mary McFarland

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Phone: (501) 371-1971

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For more information on Maryland's centerpiece, contact:
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Annapolis, Maryland 21401
Telephone: 301/280-1122

KENTUCKY

Contact: Ronald Morgan

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Phone: (502) 564-4886

Business conditions

Total electronics workforce 6,060
Average hourly wage (production line) $10.85
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects . . 3

LOUISIANA

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Business conditions

Total electronics workforce 17,500
Average hourly wage (production line) $10.30
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects . . 3

TENNESSEE

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MIDWEST

ILLINOIS

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Phone: (312) 917-7179

Business conditions

Total electronics workforce 121,800
Average hourly wage (production line) $12.50
Average hourly wage (clerical) $9.46
Average annual salary for electrical engineers $33,787
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects . 186

INDIANA

Contact: David H. Borst

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IOWA

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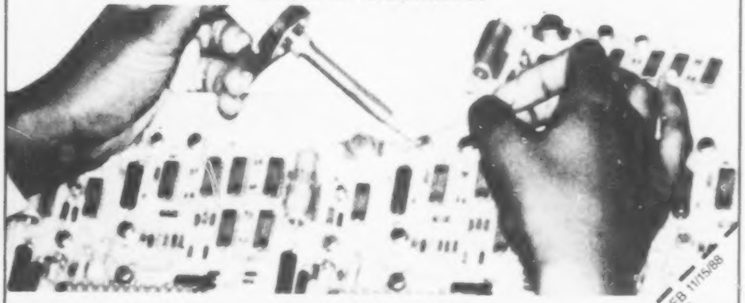
Agency: National Marketing, Iowa Development of Economic Development, 200 East Grand Avenue, Des Moines, Iowa 50309

Phone: (515) 281-3210

Business conditions

Total electronics workforce 23,595
Average hourly wage (production line) $10.77
Average hourly wage (clerical) $6.28
Average annual salary for electrical engineers $32,386
Number of colleges and universities offering

continued



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advanced degrees in electrical engineering, computer science and related subjects . . 5

KANSAS

Contact: Ed Riemann

Agency: Kansas Department of Commerce, 400 W. 8th Street, Site 500, Capitol Towers, Topeka, Kan. 66603

Phone: (913) 296-3483

Business conditions

Total electronics workforce 9,650

Average hourly wage (production line) $6.40

Average hourly wage (clerical) $6.50

Average annual salary for electrical engineers . . . . $25,000-$50,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects . . 3

MICHIGAN

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Business conditions

Total electronics workforce 82,000

Average hourly wage (production line) $9.73

Average hourly wage (clerical) $6.30

Average annual salary for electrical engineers $30,000

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects . 52

NEBRASKA

Contact: Bob Lewis

Agency: Recruitment Division, Nebraska Department of Economic Development, P.O. Box 94666, Lincoln, Neb. 68509

Phone: (402) 471-3111

Business conditions

Total electronics workforce 8,258

Average hourly wage (production line) $9.28

Average hourly wage (clerical) $4.67

continued

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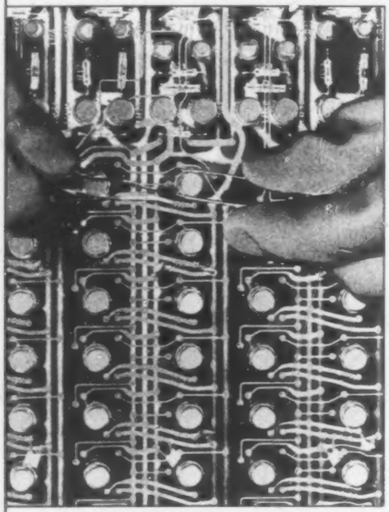

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Economic Development Department
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Scarborough, Ontario
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CITY OF SCARBOROUGH · ONTARIO

Average annual salary for electrical engineers $50,000
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects . . 2

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John J. Nevin
President
Quintron Corporation

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Executive Director
Great River Economic Development Foundation (GREDF)

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Phone: (505) 764-3750

Business conditions

Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects . . . 4

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Phone: (503) 373-1200

Business conditions

Total electronics workforce 44,300
Average hourly wage (production line) $4.34
Average hourly wage (clerical) $4.37
Average annual salary for electrical engineers (entry level) $27,000
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects . 15

WASHINGTON

Contact: Daniel D. Cudaback

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Phone: (206) 464-6282

Business conditions

Total electronics workforce 148,698
Average hourly wage (production line) . . . . $4.50-$8
Average hourly wage (clerical) . . $4.05-$8
Average annual salary for electrical engineers $32,500
Number of colleges and universities offering advanced degrees in electrical engineering, computer science and related subjects . 12

IT'S TIME TO GET OUT OF THE DARK.

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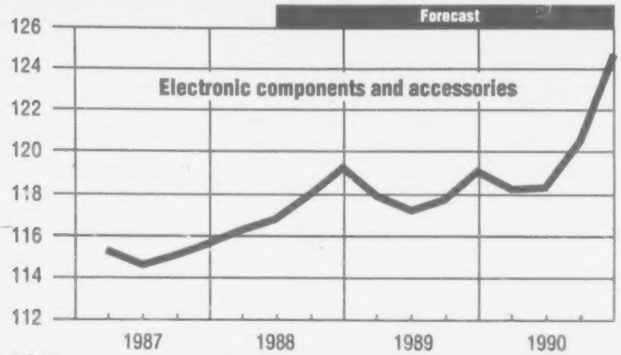
130

Producer price index — Electronic components

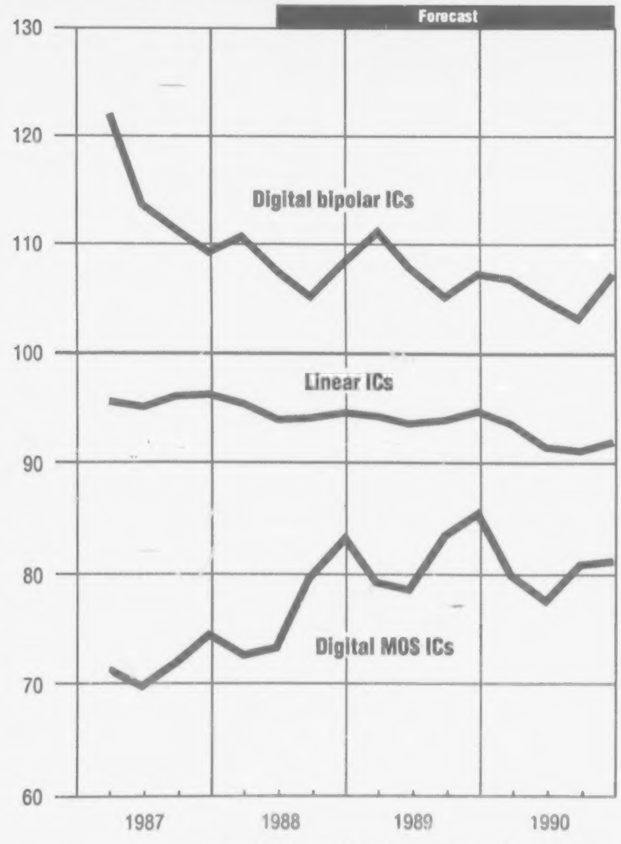
Quarterly averages, 1st quarter 1982 = 100



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Producer price indexes — Active components

Quarterly averages, 1st quarter 1982 = 100



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Capacity utilization rates are at a record high

Capacity utilization of our nation's factories teased the 84% mark in the hot summer months of July and August, a record high for this decade. Particularly hefty increases in capacity utilization rates were recorded in the primary metals and chemicals industries. But the industrial sector has reached its peak for this business cycle, so factory operating rates are heading downward through 1990.

Electrical machinery highest since 1985

In July and August, electrical machinery manufacturers kept plants running at 78.1% of capacity, the highest monthly rate since early 1985. However, industrial output in this industry is expected to slow in 1989 and early 1990. Growth in new orders for electrical machinery started tapering off in July and shipments have been flat for several months.

This letup will take the pressure off any capacity constraints. Operating rates will ease to about 76.7% through the first half of 1990, before renewed production growth kicks in additional gains in capacity utilization.

Instruments rates top 82%

Even with the addition of capacity, factory operating rates in the instruments industry broke through the 82% barrier, recording some of the highest rates in three years. Because the instruments sector is anticipated to sustain slow but steady growth next year, capacity utilization rates are expected to hover around 80% to 81% until late 1989.

Aerospace rates drop

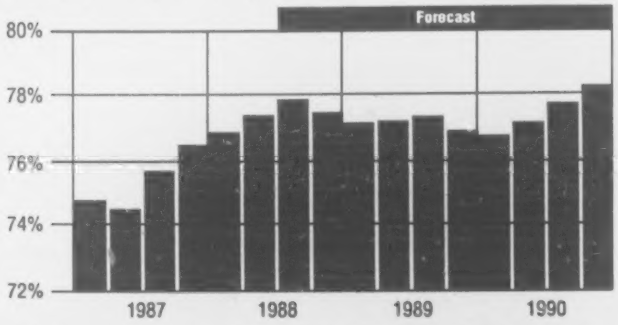
Although the capacity utilization rate in the aerospace and miscellaneous transportation industry bopped up to 87.5% in July, the rate subsided to 86.9% in August and continued its slide that began in March 1987. With defense dollars shrinking in real terms, industrial production of aircraft, ships and military tanks will wane over the next two years. This contraction is expected to shave factory operating rates down to 77% to 78% by the end of the decade.

What is capacity utilization? Each month the Federal Reserve Board estimates production and capacity of our nation's factories, mines and electric and gas utilities. Capacity utilization percentages are calculated as ratios of production to capacity. Capacity estimates are based on a variety of data, such as capacity data in physical units and surveys of capacity growth and utilization rates.

MADELINE FRANCHI

Plant utilization — Electrical machinery

Average percentage of capacity utilized per quarter, seasonally adjusted

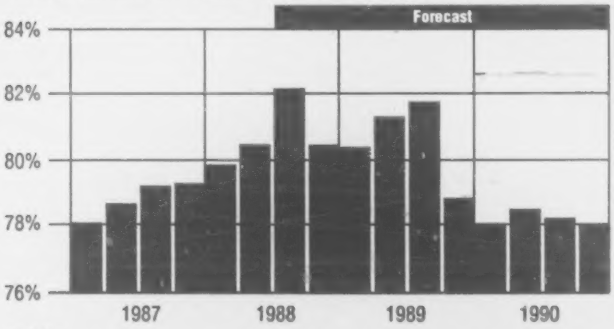


SIC 36

Historical data: Federal Reserve Board; Forecast: Cahners Economics

Plant utilization — Instruments

Average percentage of capacity utilized per quarter, seasonally adjusted

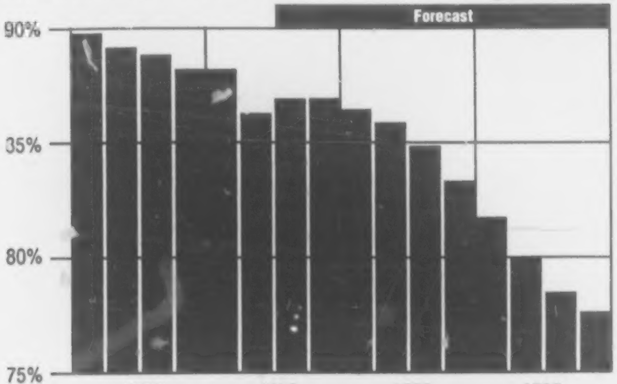


SIC 38

Historical data: Federal Reserve Board; Forecast: Cahners Economics

Plant utilization — Aerospace

Average percentage of capacity utilized per quarter, seasonally adjusted



SIC 37

Historical data: Federal Reserve Board; Forecast: Cahners Economics

IC price pressures are easing . . . finally

After a summer of rapidly rising prices for electronics components, especially for DRAMS (dynamic random-access memories), prices are finally stabilizing. Last summer's inflationary spiral was spotty, with only some components seeing sharp price increases.

According to a monthly survey of buyers made by *Electronics Purchasing*, average selling prices for DRAMS surged from $24 in April to $31 in August. As for 256-kilobit DRAMs, buyers reported average selling prices of $6.25 in August, down from $8.30 the month before and not far off from the $6.50 prices seen last April.

Buyers who were caught without long-term contracts for critical components like DRAMs have no doubt been hardest pressed to handle the summer's hot prices. While the anecdotal evidence has made headlines, on the average, price increases this year have actually been relatively mild.

The numbers behind the headline

For example, using the Bureau of Labor Statistics constant quality producer price indexes, linear integrated circuit prices fell 2.1% in the third quarter, compared with year-ago prices. Digital bipolar prices fell 5.5%. Only digital MOS devices saw a significant price rise, up 10.6%.

Even with quality changes held constant, the Bureau of Labor Statistics estimates that prices for linear ICs and digital bipolar devices grew at a 7% and 29% pace respectively in 1984. That's at the height of the 1984 supply shortages and subsequent price rises. No such dramatic price increases for these composite price indexes have taken place in 1988.

Another statistic that confirms the general boring nature of the 1988 price-supply story: leadtimes. The length of time between placement of an order for electronic components and delivery of that order stretched to a 12-and-a-half-week high in mid-1984. The highest leadtime that electronic component buyers have faced (on average) has been eight-and-a-half weeks so far in 1988.

What's ahead for component prices? Component prices and all industrial commodity prices will probably stabilize even more in 1989, before picking up again in 1990. That's premised on a slowdown in demand in 1989, so producers will be hard pressed to raise prices and buyers will encounter even fewer purchasing headaches next year.

ELIZABETH B. BAATZ

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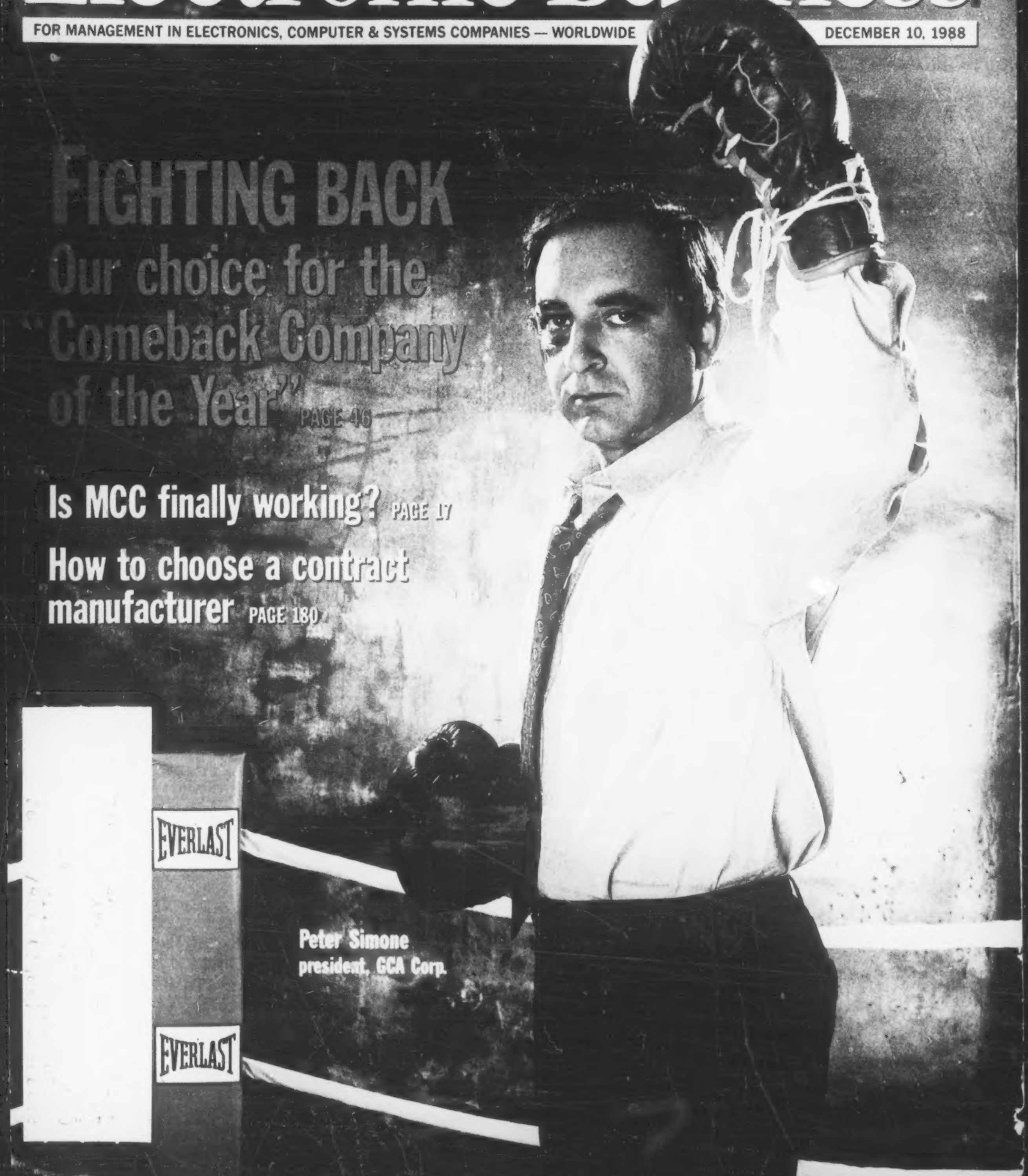
Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

DECEMBER 10, 1988



FIGHTING BACK

Our choice for the "Comeback Company of the Year" PAGE 46

Is MCC finally working? PAGE 17

How to choose a contract manufacturer PAGE 180

Peter Simone
president, GCA Corp.

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 14, NO. 23 DECEMBER 10, 1988

PAGE 46 GCA's Peter J. Simone comes back from a near knockout

COVER STORY/STRATEGIES

46 Fighting back: GCA is the "Comeback Company of the Year"

GCA's president Peter J. Simone used to box in college, but he was hardly prepared for the semiconductor industry slump of 1985 which hit the General Signal division like a knockout punch. But, under extraordinarily difficult conditions, GCA's management team has staunched a three-year flow of red ink and brought the company back from the brink of financial disaster.

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One product doesn't prove it. But participants are still enthusiastic about the electronics industry consortium

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TI's strategy to become a leader in the Unix-based workstation market rests on its AI efforts. When will those efforts pay off?

26 Third World markets for 32-bit workstations
Apollo thinks developing nations could use workstations for "social engineering." But, it may take the World Bank to make it work.

32 Swedish-Swiss merger braces European electronics
From ICs to thyristors and relays, electronics already yield over 20% of Asea Brown Boveri's $18 billion in sales.

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Wyle sets up shop on the East coast next month to peddle computers *and* components. But what will the plan do for profits?

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Almost down for the count, Peter Simone and his management team brought GCA back from the brink of disaster.

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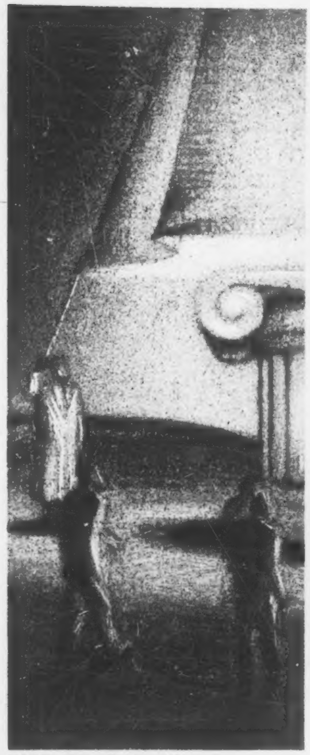
PAGE 56 Shopping spree: Foreign firms expand in the U.S.



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Just about every major computer company does its shopping in Taiwan. IBM spent $278 million there last year. Here's why.

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And the winner is . . .

Nobody can forget 1985, when the semiconductor industry slump hit the electronics industry like a hard right to the jaw. GCA Corp. was one of many firms sent reeling by the impact. But the wafer stepper company, since purchased by General Signal Corp., fought back. And president Peter J. Simone, who obligingly posed for us wearing theatrical bruises and boxing gloves, is enjoying the victory. For its efforts, ELECTRONIC BUSINESS has named the Andover, Mass., firm as its 1988 "Comeback Company of the Year."

VLSI Research Inc., a San Jose market research firm, projects that GCA will capture 13% of the estimated $940 million wafer stepper market for 1988, up from 6% last year. Our cover story marks the ELECTRONIC BUSINESS debut of Rick Whiting. Rick comes to ELECTRONIC BUSINESS as an associate editor from *Computer Systems News*. He will be keeping a close watch on the computer industry.

Associate editor Rick Whiting

High cost of test

As printed circuit board complexity rises and surface mount technology gains acceptance, the high cost of test has become a critical concern. Indeed, pressures to reduce those costs are starting to reshape the automated test equipment (ATE) industry as newcomers emerge with low-cost gear and the established vendors answer with solutions of their own. Turn to our "Market Perspectives" story by associate editor Tony Greene for more on this trend.

Consortium craze

In recent years, more than 50 consortia have been formed and touted as the salvation of various segments of the U.S. electronics industry. But can U.S. high-tech companies that thrive on cutthroat competition work together while still sharpening their competitive edge? In this issue, two stories explore the modest successes and potential pitfalls of the consortia craze.

In "Business Trends," we examine whether the six years and $200 million pumped into the Microelectronics and Computer Technology Corp. (MCC) were worth it. So far, the collaboration has one product: NCR Microelectronics' CAD software. Meanwhile, in our "Strategies" section, we wonder whether George Scalise, Maxtor Corp. president, will convince fierce Winchester disk drive competitors to drop the boxing gloves and become friendly collaborators.

BETH KARLIN, assistant managing editor

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BPA ABP

Lunch is on me

In your Sept. 1 "Viewpoint," you made a point which I have suspected for some time — unfortunately, money can buy the free press.

We are among the hundreds of small solid electronics and high-tech companies you referred to in your article. We do produce worthwhile products, contribute to the industry and spend hard earned dollars on R&D. We do not have the dollars obviously required to get material published, no matter how newsworthy it might be.

This is where I have a problem. It had always been my naive thought that news was news and was not measured by the money and power behind it. My fellow small manufacturers and I develop informative data sheets, submit product photographs, create clear and concise press releases, and, from time to time, submit technical data to editors.

Past experience indicated that either the material was deemed not newsworthy or it was buried under a pile of other submitted material, or perhaps, as your article seems to confirm, the editors were too busy being contacted and entertained or otherwise engaged with those who can afford to buy luxury.

Although this letter may sound like sour grapes, it is not. In fact, I wish to commend you on your honesty and for having the fortitude to set the record straight. I am personally disappointed to think that the press values news not by its content but by the power of the lobby presenting it. Free publicity is indeed not free; I hope it does not mean that editorial integrity is also a contradiction in terms.

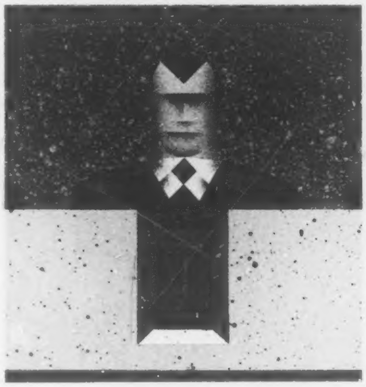
ANTHONY ANDERSON
President, Guildline Instruments Inc.
Orlando, Fla.

Editor's Note: The point is not that the editorial product is for sale at ELECTRONIC BUSINESS, but rather that information about your products is a commodity. ELECTRONIC BUSINESS is a business — not a technical — magazine. So if we have not printed your technical data and product photographs, it is because it is not our policy to do so — for a company of any size. We might, however, be interested in your business strategy if it is appropriate to our readership. I urge you to consult with your marketing staff about how to best position information for the business press. And by this I do not mean wining and dining reporters. In fact, next time you're in Boston, I will be happy to buy you lunch.

R&D spending

Your September 1 feature on R&D investment was informative. I was disappointed, however, that the author's research overlooked the research and development efforts of Network Equipment Technologies Inc. (NET) in the communications segment.

Our fiscal 1987 R&D expenditures, $5.4 million, or $10,800 per employee, outdistanced No. 18 Dynascan, which you ranked just below 3Com. Moreover, our numbers represented 11.4% of revenue for that year.



STAN DEVAUGHN
Director, Corporate Communications
Network Equipment Technologies Inc.
Redwood City, Calif.

Editor's note: To qualify for the ELECTRONIC BUSINESS R&D ranking, companies must derive at least 70% of their revenue from electronics-related sales and be included in the ELECTRONIC BUSINESS 200.

Siemens still sleepy

I enjoyed your last issue of ELECTRONIC BUSINESS about Europe, where I spent about half of my career. However, your article about Siemens shows that the slumbering giant is still somewhat in that state. For example, everyone interviewed was a German national with a certain mentality, especially after many years at Siemens. If they mean to be an American company of importance, they need imaginative American marketing and management. It's not enough to buy American companies and turn them into German versions.

Secondly, the European concept that bigness and financial size attract customers is still there. They have to compete like a start-up if they are serious. Thirdly, technical innovation needs to be sent over, so they would be better off to buy advanced companies that need financing than old established companies that make the same thing they make in Germany. In Europe, it was always good enough to make what the others did. Over here, it's better to have something your competition does not.

GEOFFREY POST
Eurotechnology
Irvine, Calif.

Distribution confusion

In an otherwise well-written story on distribution, we believe that ELECTRONIC BUSINESS erred in calculating certain aspects of the charts on pages 58 to 59 of your September 15 issue. Hall-Mark Electronics Corp. generally employs 1,350 people. Using the $475 million figure reported by Tyler Corp. as our 1987 fiscal sales, that would work out to a little more than $351,000 per employee, not the $146,600 listed in your chart.

JIM BURNETT
Director, Corporate Communications
Hall-Mark Electronics Corp.
Dallas, Texas

Editor's note: The figures used by ELECTRONIC BUSINESS were for Hall-Mark's parent company, Tyler Corp., not for the Hall-Mark subsidiary. This accounts for the difference.

Correction

In our October 1 listing of top capital spenders, Tektronix was incorrectly ranked. With capital expenditures of $66.8 million in 1987, Tektronix should have been in 32nd place.

Letters to the editor

ELECTRONIC BUSINESS
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Newton, Mass., 02158

tors to discuss technology research can be disconcerting at first, but ultimately, says Reinkensmeyer, it's not that different from discussing matters of mutual interest at a technical conference. "We have a ground rule not to discuss any proprietary research going on at member companies," he says.

Reinkensmeyer says his firm probably would not have developed Design Advisor without the preliminary work undertaken by MCC. "You can't expect every activity undertaken by a consortium to be a big hit . . . they take on the risky projects. If it was easy to do there would be no need to share the risk," he says. "But when you come up with a jewel like Proteus, it shows the real value of a combined effort."

The expert system basic design, upon which NCR's software is based, is called Proteus. Developed at MCC, Proteus combines a database with artificial intelligence to pose questions to designers. Knowledge contained in the NCR software provides access to years of experience in designing computer microcircuits, helping detect and eliminate human errors. NCR officials claim Design Advisor can solve design problems in two hours. The same problems, they say, could take 12 weeks with traditional software.

The new software runs on Mentor Graphics workstations. Plans call for it to eventually work with workstations from Sun Microsystems Inc., Daisy Systems Corp. and other companies. "NCR's strategy is to use the software to help differentiate its semicustom chips in the highly competitive ASIC market.

"I think it's the wave of the future," says Gerard Langeler, president of Mentor Graphics Corp. of Beaverton, Ore. He expects chip foundries and workstation manufacturers to use the technology to shorten product development cycles. Andy Rappaport, president of Technology Research Group in Boston, calls the new technology a "model for the kind of thing a consortium can do best." Is it enough to justify all the money that's gone into MCC, Rappaport asks, immediately answering his own question: "Probably not, but it may show the recipe for an optimal way to use consortium dollars in the future."

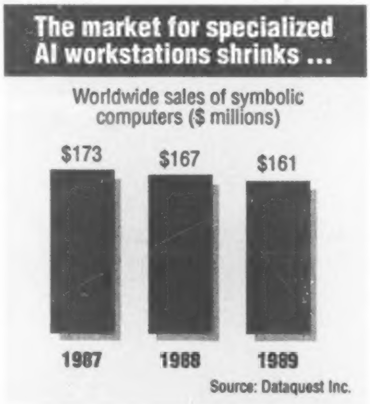
J. MICHAEL RUHL

TI throws its hat into the Unix AI ring

TI's strategy to become a leader in the Unix-based workstation market rests on its AI efforts. When will those efforts pay off?

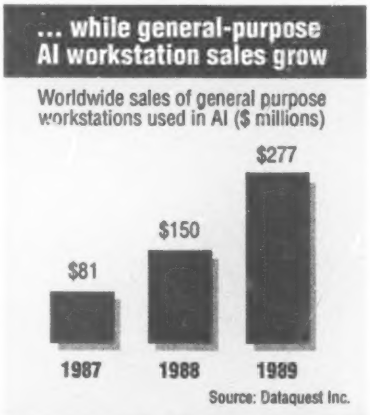
If you admire tenacity, that trait which allows companies to continue investing in a technology whose payback proves elusive, then you'll love the folks at Texas Instruments Inc.

In 1978, TI began a modest program of artificial intelligence research at its central technology labs in Dallas. Ten years later, after spending, by some estimates, several hundred million dollars on research, product development and marketing, TI's AI business has yet to turn a profit, much less pay back its investment. Despite this, TI continues to plow ahead with AI, and has made it the cornerstone of a new strategy to become a leading vendor in the competitive market for Unix-based AI workstations.


The market for specialized AI workstations shrinks ...

Worldwide sales of symbolic computers ($ millions)

Source: Dataquest Inc.


... while general-purpose AI workstation sales grow

Worldwide sales of general purpose workstations used in AI ($ millions)

Source: Dataquest Inc.

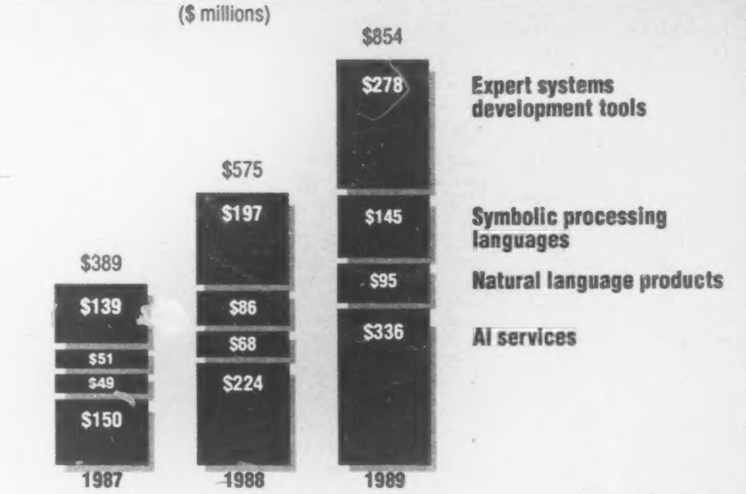
TI plans to take the Sparc microprocessor, which it licensed from Sun Microsystems Inc. in August, and develop a family of Unix-based workstations that are optimized for doing symbolic, or AI, computing. TI will move its existing AI software tools and applications, which currently run on its Explorer and microExplorer workstations, onto the new platform. And it will continue efforts to develop vertical market applications in areas where the company has already had success, such as airline operations and manufacturing.

TI hopes that its new hardware will solve a problem that has dogged its AI business for the last several years: the fact that the market for AI computers has moved away from specialized AI platforms (or LISP machines), toward general-purpose Unix workstations, such as those offered by Sun. By the mid-1980s, AI customers began to discover that they no longer needed special-purpose AI machines to run their applications; they could use a conventional Unix workstation and run a full catalog of Unix applications as well.

The Lisp machine market has dried up, and will shrink to $161 million in 1989, from $173 million in 1987, according to Dataquest Inc. of San Jose. The AI industry has seen Lisp machine makers such as Lisp Machines Inc. and Symbolics Inc. hit the skids, and TI has watched sales of its Explorer reach no more than a dribble.

TI reports that it had sold only 2,000 of the $40,000 to $50,000 Explorers by the end of 1987, a poor showing for three years of sales. And many of these were sold to other divisions within TI. The company is doing better with its new $20,000 microExplorer, introduced last March. The microExplorer uses an Apple

Worldwide AI revenue for non-hardware products



Source: Dataquest Inc.

Computer Inc. Macintosh II with an add-in board incorporating TI's custom-developed Lisp microprocessor, and gives a good amount of AI computing power at a low cost. TI expects to sell somewhere between 1,000 and 5,000 microExplorers in its first year.

Firm commitment to AI

But the sales boost from microExplorer is unlikely to offset declining sales of Explorers and sluggish sales of software, according to Sarah Spang, editor of the Manchester, Massachusetts-based newsletter, *Spang Robinson Report on Artificial Intelligence*. Spang thinks that TI's revenue from AI hardware, software and services will remain flat in 1988 and 1989, and she guesses that this figure will be around $35 million. TI, although it would not release any numbers on its AI sales, acknowledges that figure is in the ball park. Peter Van Cuylenburg, vice president of TI's Data Systems Group, adds that the firm's standalone AI operation has lost money.

These losses, asserts Susan Messenheimer, a consultant with Natick, Massachusetts-based AIM Consulting & Publications, are what caused TI to retrench last June. TI transferred close to 100 employees to other parts of the company and folded its Advanced Systems Group, the AI operation, into its Data Systems Group.

But Van Cuylenburg claims that the merger of the two groups six months ago was not a retrenchment and signifies no wavering committment to AI. This, he says, was merely part of TI's strategy to integrate its AI technology into general-purpose, commercial systems, whose responsibility belongs to the Data Systems Group. Van Cuylenburg points to a spate of new software products introduced recently and explains that the transfer of personnel was necessary in order to eliminate redundant positions. "Any time you put two P&L entities together you have redundancy," he says.

Regardless of the reasons for what will result in a reduction in personnel expense, TI still faces considerable costs in producing its new Sparc-based system, due out within two years. TI will be building several architectural features found on its Lisp chip into the new Sparc system, such as memory management, essential to AI computing and not currently available with Sparc. In addition to making operating system changes, TI must convert its software tools to the new platform. TI would not release numbers on its projected development expenditures, but says it will continue to invest heavily in its AI effort.

This new investment is clearly a gamble. Although TI's hardware offerings will be more in line with the wishes of the market, the company will be entering a bloody battleground — the market for Unix workstations. "They'll be competing in a market that's already very difficult to compete in," says AIM's Messenheimer.

Despite not yet having turned a profit, TI remains committed to its AI investment

Hopefully, software will save the day. TI has a substantial amount — some 30 megabytes — of system software that will be transferred to the Sparc system. This will create what TI expects to be the most comprehensive AI environment available. Besides incorporating various tools and utilities for development with Lisp, TI will extend the new system to the increasingly popular C++ language. Since the new system will be used for conventional, non-AI computing as well, TI will integrate its popular computer-aided software engineering tools, which currently run on an IBM mainframe, into the new system.

TI's strategy of focusing on what it calls "operations management applications" may also prove beneficial to the company. Many of the manufacturing applications were first developed inside TI's own manufacturing areas. This strategy may allow TI to establish a lock on markets with large potential systems volumes.

The general consensus among industry observers is that TI will eventually reap a reward from its investment in AI, as expert systems are deployed throughout the business world in the 1990s. "I think they are going to be long-term players," says Kenneth Sonenclar, president of South Norwalk, Connecticut-based AI market researcher, Newscience Associates Inc. Adds Spang of the Spang Robinson Report: "Basically, they've got the money to survive."

But precisely when TI's reward from AI will occur is anyone's guess. One thing is certain, at least from TI's perspective. It won't occur a moment too soon.

MICHAEL R. LEIBOWITZ

COVER STORY/STRATEGIES

COMEBACK COMPANY OF THE YEAR

The editors of ELECTRONIC BUSINESS *have selected General Signal Corp.'s GCA division as the "Comeback Company of the Year"*

Fighting back

BY RICK WHITING

Peter J. Simone used to box in college, but he was hardly prepared for the semiconductor industry slump of 1985 which hit GCA Corp. like a knockout punch. For awhile, the wafer stepper company, which has since been purchased by General Signal Corp., looked like it might be down for the count.

"I can think of two or three times where we were minutes away from Chapter 11," recalls Simone, then a vice president and now president of the firm. In 1985, the company — which the previous year had controlled 19% of a stepper market then estimated to be $967 million — recorded a net loss of over $145 million, and defaulted on payments to its creditors and suppliers.

Both analysts and current GCA executives largely agree on the factors that led to the company's free-fall: too rapid diversification; the use of debt rather than equity to fuel growth; the failure in 1984 to heed the warning signals of a downturn the following year; and too much focus on product technology rather than on customer needs.

But, from all appearances, GCA now seems to finally have its house in order. The Andover, Mass., company has streamlined its organization and has tried to focus on its core business: wafer exposure lithography.

Although General Signal does not disclose financial results for its operating units, GCA, before it was formally acquired, did report a modest profit last spring of $1.2 million (not including a gain of $215,000 for a tax loss carryforward), its first black ink in nearly three years. GCA, too, says it continues to be profitable, although it won't say by how much.

VLSI Research Inc., an independent market research firm in San Jose, projects that GCA will capture 13% of the estimated $940 million wafer stepper market for 1988 — for about $122 million in sales. That's up from 6% market share last year, when the company did $80.2 million in sales. Shearson, Lehman, Hutton Inc. analyst Stephen Balog estimates that for 1988, GCA will record net income of $8 million on sales of $140 million.

In recent months, too, GCA has been winning orders for its Model 8500 DSW Wafer Stepper — including one from Motorola Inc. with a value of some $8.4 million; and its ALS laser-based system, which began shipping this year, is likewise said to be winning acceptance in the semiconductor community.

Customers that have remained loyal to GCA through the bad times — and there were some very bad

EVERLAST
EVERLAST

In the dark days of 1985-86, GCA president Peter Simone says that bankruptcy was a constant threat

Renee Fraser

John Halter, Simone's boss at General Signal, says GCA is committed to an aggressive R&D program

Martin Cooke

times — say they did so for somewhat selfish reasons: they had an installed base of machines to protect, and they would like to have people from GCA around for service and support. But customers also told ELECTRONIC BUSINESS — which selected GCA as this year's *Comeback Company of the Year*, that they believe in the company and its products. They also emphasize the need for a U.S.-based wafer stepper company.

Customer support

"We need companies like GCA to survive and even thrive to be competitive with Japan," says Gil F. Amelio, president of Rockwell International Corp.'s Rockwell Communications Systems unit, and supervisor of that company's semiconductor operations. Since the early 1980s, Japanese companies such as Nikon and Canon Inc. have grabbed large shares of the worldwide wafer stepper market. Amelio, a longtime GCA customer, maintains that from a semiconductor industry point of view, it is advantageous to have a domestic wafer stepper manufacturer such as GCA.

Amelio admits, however, that "our whole factory is based on their products. There was self-interest there." As a result, Rockwell continued to purchase equipment from GCA during the bad years of 1985-1987, even though Amelio admits being nervous about GCA's chances for survival.

But the need to defend an American presence in the global semiconductor equipment market was a compelling factor. "On a selfish basis, we should support the hometown boys before turning to other companies from outside," agrees Raphael Klein, president of Xicor Inc. in Milpitas, Calif. He calls the purchase of a GCA product "a strategic investment" for his company and others like it.

"GCA has been our supplier of systems for some years," Klein says. Xicor has an installed base of nine GCA systems and ordered two more in September. "We continuously bought from them, despite their difficulties. We had confidence in them."

Other companies echo Klein's sentiments. Jim Echols, wafer fabrication operations manager for Motorola, says his company stuck by GCA because of the extensive user training GCA offered, the easy-to-maintain systems and quick availability of spare parts. "I don't think we've ever had a bad taste in our mouths from dealing with GCA," Echols says. "When it came time to upgrade, there was never any doubt in our mind who we were going to go with."

Turnaround signs

The first signs of a turnaround actually came last May. After nearly three years of red ink, GCA reported a first quarter operating profit of nearly $1.2 million. Then, in June, General Signal completed its acquisition of the firm for $49.6 million, providing a badly needed capital infusion.

Those results are in marked contrast to GCA's showing for the previous three years. "They were just bleeding red ink all over the place," Dan Hutcheson, president of VLSI Research, recalls. "They were the prime example of how not to run a semiconductor equipment company."

Industry watchers say that in the years leading up to the slowdown, GCA may have alienated its customers by focusing more on product technology than on user needs. As an example, Hutcheson cites one incident from the early 1980s when NEC Corp. came shopping for a wafer stepper and asked for a custom system. When GCA said no, the chip maker turned to Nikon, which provided NEC with the equipment it wanted.

Simone provides his own example. He says GCA once devoted much of its development resources to shrinking the footprint of a new wafer developer system with a large potential customer in mind. "But in reality, we probably should have put more [effort] into reliability," Simone says, in retrospect. The targeted customer eventually bought another system from a competitor.

"We were the experts," Simone acknowledges of GCA's attitude. He says the company failed to understand that once customers take possession of a system, "then *they* become the experts. Because remember, they now understand your product, plus they know the process to which they are applying the product. And I don't think we reacted well to the information coming back."

Not surprisingly, customer confidence began to erode. A 1987 VLSI Research survey of GCA customers showed that 16% vowed never to buy equipment from the vendor again, and, on a scale of one to 10, the survey gave GCA unimpressive scores of 6.8 for service after sale and 5.9 for technical leadership.

Customers remained loyal to GCA because they wanted to support a U.S.-based company

Simone says that in 1984 and 1985, the reputation of GCA's equipment was often better than the products really were. Today, he believes GCA has quality products, but the company must rebuild its reputation. "It took us time to get into trouble and it's going to take us time to get out of trouble," he says. And there are indications that GCA's efforts to improve customer relations are working. Although VLSI Research is still compiling the results of its 1988 customer survey, Hutcheson believes that GCA is no longer suffering a deterioration in customer confidence.

Manufacturing innovations

To correct past errors, GCA is now experimenting with a variety of manufacturing techniques to ensure customer satisfaction. Today, anyone within the company can halt system shipments if there is any doubt about the product's quality, according to Simone. "Consistent product quality is the key," he says, adding that the company is beginning to see more repeat business than before.

To further improve relations with its user base, GCA has also begun holding regular meetings with its customers and, Simone believes, become more open to feedback. "We've come to the realization that the only way to really know whether you're succeeding or not is for the customer to tell you," he concludes. "If you're evaluating yourself, you're not going to get an objective opinion."

"They are learning to think more from the customer point of view," agrees Rockwell's Amelio.

GCA also made a strategic decision to continue investing in research and development, despite its financial woes. Both Simone and John E. Halter, vice president for operations at General Signal, to whom Simone reports, believe that GCA's decision to invest heavily in R&D was a major factor in the company's survival.

The funding was necessary to develop the line of excimer laser-based steppers on which the company is gambling its future. The systems marked a change in direction from the X-ray technology-based products being produced by its competitors.

Some of its R&D funds have also gone into upgrading existing systems. GCA had been experiencing problems with its Model 6000 DSW Wafer Stepper series. Although Simone considers the systems to have been technologically worthy, he says they were time-consuming to set up and test and were difficult to adapt to individual customer applications.

To improve the reputation of that product line, GCA in 1986 began shipping in volume the Model 8000 DSW Wafer Stepper series, described by Simone as "our first really solid systems." Today, such customers as Klein at Xicor applaud the systems as easily upgradable.

Need for stability

Under General Signal, GCA also wants to reduce the management turnover which contributed to the company's downward spiral during 1985-86. "We needed some outside people, but I think we made too many top management changes. I think that's one of the reasons we lost our way," according to what Simone says. Also echoing that same belief is Jim Echols at Motorola. "It just seemed to me that they were going through a lot of personnel changes at the high levels and some continuity

A chronology

Mid-1985: Wafer-stepper maker GCA Corp. suddenly faces a financial crunch when the semiconductor equipment industry is hit with a sudden downturn. By the end of the year, the company will lay off 830 workers, consolidate its operations and sell off several divisions.

February 1986: Richard D. Stewart resigns as president and chief operating officer, while Milton Greenberg retires as chief executive. Director Leonard S. Sheingold briefly holds the president's post, followed by an "office of the president" made up of Peter J. Simone, John H. Bruning, and Louis F. Bieck, who is supervising international operations. The same month, lenders plan to accelerate loan repayment schedules, possibly triggering a bankruptcy filing. Simone talks creditors into granting "a stay of execution."

March 1986: Richard P. Rifenburgh is appointed chairman and chief executive.

February 1987: Simone is named president.

April 1987: GCA undergoes a major financial restructuring, called "a private Chapter 11" by one analyst. Rifenburgh departs.

July 1987: GCA names David R.A. Steadman, president of a Raytheon Co. venture investments division, to serve as chairman and chief executive. GCA begins to see signs of an upturn when third-quarter order backlog is more than double that of the second quarter.

October 1987: GCA's plans for a public offering are thwarted by the stock market crash. Negotiations to be acquired by General Signal Corp. begin.

March 1988: General Signal agrees to pay $5.22 a share or $49.6 million for GCA. The acquisition takes place in June.

was lost," according to Echols.

As the 1985 semiconductor equipment slump neared, other actions — or inactions — by GCA's top management helped set the stage for the company's decline. Rapid expansion and diversification, continued production, high levels of debt, and "a management that had its head in the sand [and] didn't see it coming was the recipe for disaster," says Bruning.

GCA had grown rapidly and the company's top management did not believe the good times would come to an end, according to Eberstadt Fleming Venture Capital analyst Timothy J. Allen. "That was not seeing the handwriting on the wall when it was pretty damn clear," he says.

"There was this overwhelming view that we were in a business that just couldn't turn down," says John H. Bruning, then a vice president, and today GCA executive vice president, chief technical officer and president of its Tropel industrial lens division. "And when the signals for the downturn in 1985 came along, they were just regarded as nonsense."

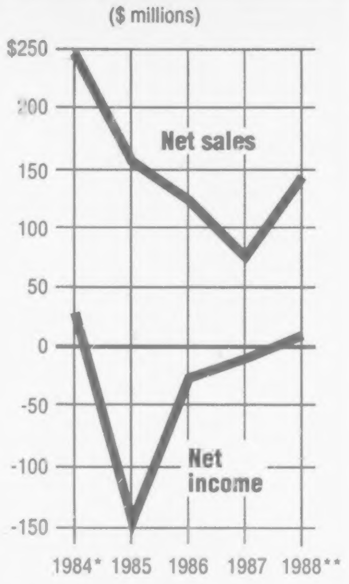
But Richard D. Stewart, GCA's president and chief operating officer between 1984 and 1986, says the company continued to receive orders for production equipment despite growing indications of a slowdown in the semiconductor market. On that basis, he says GCA maintained its production levels.

"It was our view that the chip industry was continuing to build plants" and expand production in expectation of long-term growth, he says. It was not until several large orders, reportedly from AT&T, Hitachi Ltd. and others were canceled, that the slump hit home.

Currently chief executive and president of Computer Corp. of America in Cambridge, Mass., Stewart says he resigned his GCA posts because of "a combination of things," but chiefly the opportunity offered by the CCA job. Currently in retirement in Tucson, Ariz., former GCA chairman and chief executive Milton Greenberg declined to comment for this story.

GCA was rapidly diversifying into such areas as robotics and scientific instruments "when it should have been squirreling away money for a rainy day," Bruning recalls. Just before the slump, GCA had even begun site preparation work for a $40 million optics development and manufacturing facility in Rochester, N.Y.

GCA's turnaround



* 1984 restated to separate results of continuing operations from those of discontinued operations

** Shearson, Lehman, Hutton estimates

Sources: GCA Corp., Shearson, Lehman, Hutton Inc.

"I think that one of the fundamental problems we had was that we were trying to diversify and grow at the same time, and we just didn't have the infrastructure," Simone says.

GCA's vertically integrated manufacturing made it more difficult to rein in expenses when the slump came, according to Hutcheson. Another problem was the company's bloated army of research and development engineers, which the analyst says were unable to get new products out the door.

Increased competition

Simone also argues that the company was facing increasing competition from Nikon, Canon and other Japanese wafer stepper equipment manufacturers. But Hutcheson believes the inroads made on GCA's turf by the Japanese companies were more a result — rather than a cause — of the U.S. company's decline. As a result of this, a weakened GCA gave the Japanese vendors the opening they needed to gain market share.

When the downturn actually hit in the summer of 1985, Simone, then in charge of GCA's international operations, was on a trip to China. He returned to find the company suddenly on the financial brink. "Once the mistake was made of building for this huge demand that was expected in 1985, and then funding that with debt, there was no way to react," he says.

While a bankruptcy filing might have been the quickest way to buy time for the struggling GCA, Simone believed the cost in lost customer confidence would be too high. "It was important that we do our damndest to stay out of Chapter 11," he says. "I felt that with a Chapter 11 scenario, we just couldn't sell $1 million pieces of equipment requiring a high level of support."

GCA immediately consolidated its manufacturing, administrative, and R&D operations into the Andover plant and vacated leased facilities in Massachusetts, Illinois and Minnesota, totaling some 500,000 square feet. In September, the company's vacuum metals processing division was sold and plans were made to sell off the factory automation and scientific and analytical equipment divisions in 1986.

By the end of 1985, the company had slashed its payroll by idling 830 employees in three waves of layoffs. Combined with the sold-off divisions and another 180 workers laid off in October 1986, GCA's total employment, once as high as 3,500, today stands at around 1,100.

GCA's management never promised its employees that each layoff would be the last, according to Simone. "If there is a lesson to be learned, it is that you're better off telling them the absolute blatant truth." GCA even paid its workers a week in advance to avoid delayed paychecks in the event of a sudden bankruptcy filing.

GCA's financial juggling act would continue throughout the year of 1986. Simone recalls one instance in February when the company's lenders said they were accelerating loan repayment schedules — a move that could have triggered a bankruptcy filing. "I can remember personally asking them to hold off," he says, "and they gave us a stay of execution." In

April, the board of directors all resigned when the company could no longer afford their liability insurance premiums.

Fat trimming

Hutcheson says that turnaround expert Richard P. Rifenburgh, named GCA chief executive on March 15, 1986, and later appointed president, was critical in overseeing the company's relationships with its creditors and providing the financial management the ailing company needed in 1986 and early 1987. (Rifenburgh left GCA in April of 1987 and was succeeded as chairman and chief executive by David R.A. Steadman, president of Raytheon Co. venture investments division. Steadman left after the acquisition by General Signal.)

Despite the turnaround, Simone is still keeping a wary eye on the economy

But Hutcheson also says Simone, Bruning, and other GCA veterans provided continuity and ensured that only the company's fat — and not its heart — was trimmed during the consolidation. Simone credits his management team with helping to bring about GCA's turnaround.

In April 1987, GCA restructured its finances by renegotiating its debts to its lenders, a consortium of 14 banks and insurance companies, and received an infusion of cash through a rights offering underwritten by The Hallwood Group Inc. financial services firm. GCA renegotiated debts with its suppliers, including Digital Equipment Corp., Hewlett-Packard Co., IBM and other small companies. As with GCA's lenders, the vendors had to accept about 50 cents on the dollar for the outstanding debts.

Simone recalls that at one critical point during the financial negotiations, Rifenburgh was on the phone trying to convince a holdout creditor to accept the restructuring plan. At the same time, some of GCA's biggest customers, invited to hear details of the restructuring, were waiting in another part of the company's headquarters. Had Rifenburgh's efforts failed, the customers might have heard an announcement that GCA was filing for bankruptcy.

The bridge financing GCA obtained in the April 1987 restructuring was intended to hold the company until a planned public offering in October. But like a fighter struck with one last blow before the bell, the stock market crash came on the eve of the public offering. Shortly thereafter, General Signal proposed a buyout and the deal was struck in March 1988. "The turnaround was pretty much in place by the time General Signal bought them," Hutcheson says. "I think they would have survived," agrees analyst Allen, but he believes the company would have had difficulty financing its capital needs had it not been acquired.

General Signal's Halter believes that the acquisition has helped GCA overcome credibility problems due to the company's "shaky financial situation." GCA is part of General Signal's Semiconductor Equipment Group, as is Ultratech Stepper of San Jose, another wafer stepper systems vendor. While GCA and other General Signal units may share technology or other resources, Halter says GCA will remain fairly autonomous under its parent company.

The decision

How we chose the *Comeback Company of the Year*

After an informal survey of independent analysts and leading figures in the electronics industry, GCA Corp. was selected by the editors of ELECTRONIC BUSINESS as *Comeback Company of the Year*.

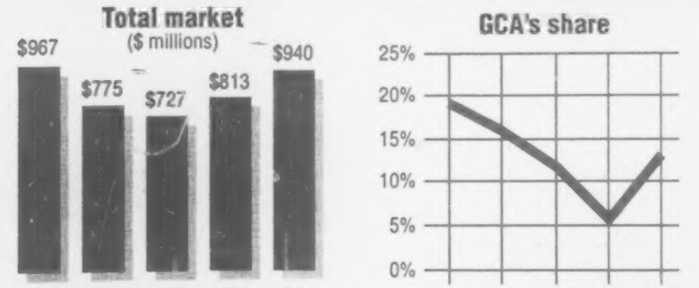
Under extraordinarily difficult conditions, GCA's management team — which included both past and current executives —staunched a three-year flow of red ink and brought the company back from the brink of financial disaster.

GCA accomplished this task through discipline and considerable sacrifice at both the management and staff levels. ELECTRONIC BUSINESS applauds GCA — and its parent company General Signal Corp. — for its remarkable achievement.

AL FURST

GCA starts to rebuild its market share

Worldwide wafer exposure lithography market



Source: VLSI Research Inc.

But Simone says that GCA is not completely out of the woods, noting that the cyclical semiconductor business has made chip manufacturers cautious about capital spending. Unlike the boom years before 1985, when systems were ordered in large numbers far in advance, customers today generally place small orders with leadtimes of only 90 to 120 days. "We're making money. But these are good times. We should be making more," he laments. Analysts' predictions of slower growth for semiconductor production equipment vendors in 1989 add more clouds to GCA's horizon.

"We're fighting a time and credibility battle to get ourselves back into competition," agrees Bruning. "I think teetering on the edge of bankruptcy for a few years is a very humbling experience." □

Shopping spree: Foreign firms expand in the U.S.

The cheap dollar has made U.S. expansion a bargain. And fears of protectionism have made growth here a high priority for overseas firms

BY RAY WISE

Foreign electronics companies are rapidly expanding their shares of the U.S. market. (On the following pages, ELECTRONIC BUSINESS ranks the top foreign companies in the United States.) Overseas firms are not only selling more here, they are manufacturing more as well. Indeed, the strength of many currencies against the depressed dollar is prompting foreign companies to acquire — or expand their own — businesses here at a bargain price.

"Japan and the United Kingdom have been particularly active, but they are not the only countries involved," according to Alex Ladias, research manager for the Chicago-based merger consulting firm of W.T. Grimm & Co. Ladias figures that 151 U.S. mergers and acquisitions were announced by foreign companies in the first half of 1988, sharply higher than the 99 such transactions in the year-earlier period. More than a dozen U.S. electronics firms, or parts of them, have been acquired by overseas buyers since early 1987, Ladias estimates. France's Thomson-CSF, of course, acquired the consumer products division of General Electric Co. And Siemens AG bought a 60% stake in Telecom Plus International, a communications concern based in Long Island City, N.Y.

For the Japanese, in particular, U.S. expansion results partly from their growing fears of protectionism and partly from their move into more sophisticated industrial electronics. "If they sell a product locally, they want to make it locally," says Bill Ebsworth, portfolio manager of the Fidelity Pacific Basin Fund. Foreign firms aren't just buying existing businesses, they're shopping for new sites and plants as well.

Hitachi America Ltd., Tarrytown, N.Y., makes a wide range of products in the United States, including computers and telecommunications equipment. It even exports disk drives from its Norman, Okla., facility to Europe. "One of our strategies is to increase our manufacturing base in the U.S.," says Harry W. McGrath Jr., deputy general manager for corporate administration.

Canon Inc. generates a third of its worldwide sales in North America, and its U.S. manufacturing output contributed to a U.S. sales gain of better than 90% in 1987. Demand runs especially high for Canon's chip-making equipment, laser printers and facsimile machines.

Since early 1987, more than a dozen U.S. electronics firms have been acquired by overseas buyers

Matsushita Electric Corp. of America, Secaucus, N.J., operates eight plants in the U.S. and expects to add more, according to a company spokesman. "We are still on a roll and looking to other operations," he says. Matsushita's presence in the United States dates back to 1974, when it acquired the consumer products division of Motorola Inc. and its Quasar brand name. In the past five years, it has added components, car speakers, cellular mobile telephones, pagers and VCRs. Workers at a new Atlanta facility are turning out electronic point-of-sales systems. Factories under construction in Troy and Columbus, Ohio, will manufacture CRTs and (in partnership with Eastman Kodak Co.) consumer batteries.

The steep drop of the dollar from a high of ¥260 to ¥120 put expensive price tags on Japanese-made products sold in the United States and served as a strong incentive to expand U.S. manufacturing. Yet, plans by some Japanese electronics concerns were laid years before the big currency move began in 1985. "If the dollar had not dropped, maybe we would now have only four or five U.S. plants," says the Matsushita spokesman. "The yen situation only served to accelerate the process."

Japan doesn't have a monopoly on the make-it-where-you-sell-it strategy. In fact, this approach is strongly espoused by N.V. Philips GL, the Dutch electronics giant with the largest presence here. Sales in the United States account for 20% to 30% of the company's total revenue. And Philips intends to increase its stake to the 40% to 50% range, concentrating on components, consumer electronics and information technology. "Philips has a policy of raising its local manufacturing resources to the level of its local sales," says Albert Ruttner, a vice president in Philips' New York City office.

Japan is moving especially fast, however. Its push away from a complete focus on mass-produced consumer electronics into more sophisticated high-end industrial products requires a production presence in the countries where they are sold. "Once you introduce new technology, you bring in a new set of problems and you have to be close to your customers," agrees Roger A. Schwantes, vice president for product tehnological development in the Nashville, Tenn., office of Canada's Northern Telecom Inc.

Clearly, the Japanese move into the U.S. industrial electronics market

Roger Roth

will entail technological development, and the stakes go beyond the enhanced profitability that is attainable with higher end products. Robert E. Johnson, technology analyst specializing in Japanese companies for Swiss Bank Corp., points out that the gradual shift will help Japan maintain its competitive edge over South Korea and the other fast-growing, newly industrialized countries (NICs) of the Pacific Basin.

The emerging competition apparently is beginning to figure in the long-term strategies of the big Japanese electronics outfits. "Their focus for the future is on industrial electronics. They realize this is where the growth is, and where there is more value added" says Johnson. And Laura Luckyn-Malone, portfolio manager of the Japan Fund, New York City, agrees: "This is the trend, and there is no going back."

Japanese firms realize that sustaining the trend will require creativity, the portfolio manager says. "There is a definite shift in Japan toward becoming a major technological innovator," says Luckyn-Malone, and some of the R&D will be transplanted to the United States. The basic research for Hitachi America now is done in Japan, but there are plans to phase it into the United States over the next five years.

The absence of a major Japanese research presence in the United States is blamed by some analysts for some big mistakes made by the country's electronics industry, in particular, missing the boat on the personal computer. "If you weren't here, you couldn't participate in the development of the PC," adds Johnson.

Selective threat

Japan's manufacturing and research beachhead in the United States is being built on a very small base — the annual revenue of IBM alone is more than three times the aggregate U.S. sales of the seven Japanese electronics companies with the largest stake here. And analysts see the competitive threat posed to U.S. companies as being highly selective. The U.S. electronics industry is expected to retain dominance in nonmemory chips, software, high-end and low-end hardware and chemical process chip-making equipment, according to Johnson. Yet, he sees the Japanese looming large in the optical technologies — laser printers, optical storage devices and optical readers.

While the Japanese electronics companies reserve their worst fears of protectionism for the United States, they also are looking to 1992, when the restructuring of the European economic community into a single marketplace is scheduled to take place. So a manufacturing buildup in Europe is also likely, according to Fidelity's Ebsworth. "The Japanese want to get in before the gate is closed."

As if to underscore this incipient globalization, Matsushita in October announced a realignment of its corporate structure along global lines. The main Osaka office will direct operations in Japan as one of four management headquarters; the Secaucus office will oversee North American, South American and Latin American operations; Europe and Africa will be the under the jurisdiction of London headquarters; and there will be an Asia-Middle East headquarters at a site not yet selected. "The aim is to make each region as self-sustaining as possible," says a spokesman.

The long-range globalization of the Japanese electronics industry will vary in scope and speed from company to company and will not necessarily be easy, according to Johnson. So far, he says, Japanese executives haven't excelled at working with people of other cultures. Explains Johnson: "They are used to a monocultural environment." □

Top foreign companies in the U.S.

Rank	Company	U.S. electronics sales ($ millions) 1987	U.S. electronics sales ($ millions) 1986	1987 total consolidated sales ($ millions)	1987 profit before taxes ($ millions)	Fiscal year ended	Country of origin
1	**Philips**	$5,300	$3,993	$25,968	$501	12/87	Netherlands
2	**Matsushita**	4,300	3,700	34,839	3,117	3/88	Japan
3	**Northern Telecom**	3,103	2,860	4,854	449	12/87	Canada
4	**Sony**	3,081	2,634	10,347	531	3/88	Japan
5	**Toshiba**	2,880	2,000	25,827	907	3/88	Japan
6	**Hitachi**	2,811	3,030	35,967	2,394	3/88	Japan
7	**NEC**	2,300	1,948	19,626	507	3/88	Japan
8	**Canon**	2,194	1,150	6,753	278	12/87	Japan
9	**Siemens**	1,910	1,500	27,503	1,390	9/87	West Germany
10	**Sharp**	1,800	1,600	8,857	312	3/88	Japan
11	**Fujitsu**	1,570	1,170	14,797	848	3/88	Japan
12	**Mitsubishi**	1,200	1,200	14,435	261	3/87	Japan
13	**CGE**	1,200	865	21,208	744	12/87	France
14	**GEC**	1,122	1,100	9,457	1,206	3/88	Britain
15	**Sanyo**	1,120	1,200	8,046	4	11/87	Japan
16	**Samsung Electronics**	1,048	800	2,882	55	12/87	Korea
17	**Thomson-CSF**	800	425	5,970	619	12/87	France
18	**Olivetti**	653	835	5,688	415	12/87	Italy
19	**Bayer**	600	370	20,635	1,703	12/87	West Germany
20	**C. Itoh**	500	500	101,112	152	3/87	Japan
21	**Kyocera**	554	542	2,172	364	3/88	Japan
22	**Lex Services**	539	442	2,360	77	12/87	Britain
23	**TDK**	524	450	2,701	284	11/87	Japan
24	**Pioneer Electronic**	517	470	2,424	160	9/87	Japan
25	**Racal**	500	475	2,328	235	3/88	Britain
26	**Schlumberger**	480	450	4,727	619	12/87	Netherlands
27	**Thorn EMI**	477	430	5,201	384	3/88	Britain
28	**Lucky-Goldstar**	443	398	14,422	NA	12/87	Korea
29	**Oki Electric**	437	460	3,263	76	3/88	Japan
30	**Ericsson**	413	400	5,102	174	12/87	Sweden
31	**Alps**	325	325	2,532	98	3/87	Japan
32	**Daewoo**	350	NA	18,000	NA	12/87	Korea
33	**Plessey**	309	280	2,216	293	3/88	Britain
34	**Casio**	300	NA	1,430	47	3/87	Japan
35	**Ciba-Geigy**	248	NA	10,580	NA	12/87	Switzerland
36	**Commodore**	223	230	871	68	6/88	Bahamas
37	**Bosch**	201	180	14,091	966	12/87	West Germany
38	**Brother Industries**	198	185	1,129	83	11/87	Japan
39	**Hanson**	171	NA	10,409	1,154	9/87	Britain
40	**Ferranti**	158	97	1,400	116	3/88	Britain

U.S. electronics sales are ELECTRONIC BUSINESS' estimates. All figures are converted at the exchange rates for the latest fiscal years, thus a variety of accounting and exchange rates are represented

Source: ELECTRONIC BUSINESS

Can fierce Winchester competitors become partners?

Maxtor's George Scalise wants U.S. drive makers to form a consortium to counter the Japanese. His biggest problem may be convincing his counterparts that it's necessary

BY MICHAEL R. LEIBOWITZ

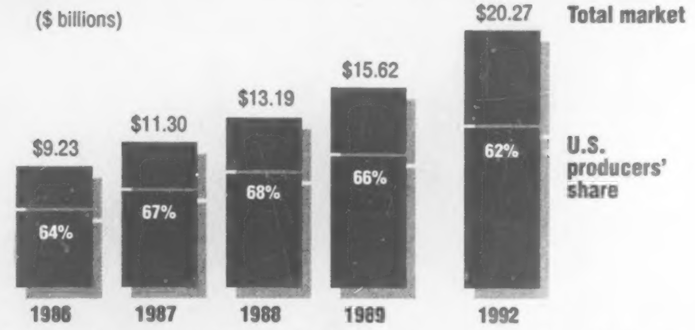
It's hard to imagine executives of the fiercely competitive United States Winchester disk drive industry sitting together in the same room, much less shaking hands and agreeing to form a consortium. Yet if George Scalise, former chip industry executive and Maxtor Corp. president gets his way, the United States drive industry will do just that.

As the force behind an effort to form an industry consortium, Scalise wants drive makers to set aside their differences to do such things as fund university R&D and lobby Washington on trade issues. Although the precise objectives of the consortium were still fuzzy when Scalise initiated a meeting of 25 drive makers at an industry convention in September, the overall objective, he says, was clear: U.S. drive makers must band together to guarantee their future health.

With research in important disk drive technologies shifting from the United States to other countries — notably Japan — Scalise says, the drive industry here can no longer be complacent about retaining its leadership. Not only must drive builders begin to pool R&D resources to counter this trend, he continues, but they must make Washington aware of their strategic importance. With the support of Washington, the industry can do such things as influence trade legislation to its benefit, and perhaps, win R&D tax credits to help fund new research.

By the end of the meeting, Scalise had already won the support of several executives. CEOs of three companies: Finis Conner of Conner Peripherals Inc.; Lawrence Perlman of Imprimis Technology Inc.; and Stuart Mabon of Micropolis Corp.; agreed to join Scalise in forming a subcommittee to propose a specific agenda for the future consortium.

Worldwide market for Winchester drives



Based on factory revenue, not including retail or distribution markup

Source: Dataquest Inc.

Some in the industry question the need for a consortium, since the U.S. disk drive industry controls about 67% of the worldwide market

But others are either opposed or undecided. "I personally don't think that Seagate would want to belong to it," says Al Shugart, chairman of the leading Winchester drive maker. Says another CEO, who asked not to be identified, "It seems to me that this is a solution looking for a problem. There isn't a real cause on which to rally at the moment."

Borrowed strategy

In proposing the consortium, Scalise is borrowing a strategy that he helped develop during his 29-year tenure in the semiconductor industry. Specifically, he hopes to unite U.S. competitors to counter Japan Inc. As chairman of the Semiconductor Industries Association (SIA) public policy committee, Scalise helped plan and win passage of such landmark legislation as the U.S.-Japan Semiconductor Trade Agreement, intended to eliminate Japanese chip dumping. He was involved in three R&D consortiums designed to counter the Japanese threat — as a cofounder and director of the Microelectronics and Computer Technology Corp. (MCC), as chairman of the Semiconductor Research Corp., and as one of the early planners of Sematech.

But grafting the semiconductor industry's successful formula onto the drive industry may be difficult, according to some experts. While the U.S. semiconductor industry could point to markets that it had lost to the Japanese, the drive industry cannot. In fact, the U.S. drive industry commands 67% of the worldwide market in terms of revenue, a number which has actually risen in the past five years, according to Phil Devin, an analyst with Dataquest Inc. of San Jose. As it turns out, U.S. disk drive makers' keenest competitors are other American suppliers, not the Japanese.

But the United States can lose its lead, warns Scalise and his supporters. They contend that not enough research is being done in fundamental technologies such as magnetics and electro-optics to assure the industry's future innovations. Perlman of Imprimis points to a 1985 National Academy of Sciences study that showed that the United States is falling behind Japan in magnetics research, a technology important to disk drives. Says Perlman: "When we have a large magnetics conference in the United States, we have trouble finding enough Americans to evaluate the papers contributed."

Conner, meanwhile, complains that the U.S. drive industry is dependent on Japan, which supplies most of the drive heads, disks and motors used in Winchester drives. "We've got to find ways to stimulate development and manufacturing of those products here in the United States," says Conner. Unless this happens, he contends, "the whole industry is at risk."

Conner would like to see the consortium lobby Washington for R&D tax credits for conducting fundamental research, especially in view of the government support given foreign competitors. The government hinders innovation, according to Conner. "In our first year of production, we paid over 40% in taxes. That's ludicrous."

Scalise supports a tax credit effort, but cautions that this is too big an issue to tackle alone. "You have to generate a much broader constituency for that," he says. A more realistic early goal for the consortium, he says, will be to concentrate on influencing international trade legislation. One of the first items on the agenda might be to remove Winchester drives from the list of products that are subject to export documentation under the trade bill passed this year. The group may establish a monitoring program to identify other legislation that could affect the industry.

In R&D, Scalise says that he would like the consortium to start off by funding university research at such centers as Carnegie Mellon University and the University of California, San Diego. "The example here is Semiconductor Research Corp.," says Scalise, referring to the organization that supports university-level research from funds provided by semiconductor and equipment makers. Later on, he says, he would like to form a Sematech-like venture that performs joint R&D.

Consensus lacking

But before any of this can happen, Scalise has to develop a compelling plan that will win the support of the other drive makers — companies with vastly different interests and needs. Given the current slump in business, disk drive makers are not in the mood to spend great amounts of money on programs that appear to be of questionable use.

Maxtor president George Scalise would like to fund disk drive research with a Sematech-like venture

If the consortium funds university research, for example, it risks losing the support of potential members such as Al Shugart of Seagate and Joseph T. Rodgers, chief financial officer of Quantum Corp. Shugart believes that his company can derive the most benefit from university research by funding this itself, which it already does. Quantum's Rodgers does not want to contribute to research, preferring to leave this to his component suppliers.

The idea of lobbying Washington appears to have more support from drive makers, who recall the successful effort that Scalise led recently to get import tariffs removed from drives assembled overseas. "An individual company can't put a lot of input into the lawmaking process," explains Seagate's Shugart, who lists lobbying as "the only thing that would cause me to consider joining a consortium."

Quantum's Rodgers is also in favor of uniting the industry to influence legislation. But he wonders whether a major lobbying effort is necessary, given the absence of specific issues right now. Instead, Rodgers says that a better plan would be that proposed by Censtor Corp. chairman, Ed Zschau at the September meeting: Maintain a mailing list of members and bring them together when there is specific legislation that needs attention. At that time, funding can be raised and lobbying begun.

It is quite unlikely that the consortium will win everybody's support. And although it might be nice to have everyone's support in a lobbying effort, it is not vital, according to David Yoffie, an associate professor at the Harvard Business School and expert on business-government relations. But nonmembers cannot actively oppose the lobbying agenda. "That undermines any action," according to Yoffie.

To be effective in lobbying Washington, the consortium will need money and a substantial commitment of time by certain members. Yoffie pegs the cost for a full-time Washington lobbyist, office and secretary at $1 million. More expensive is the time required of key executives and managers in order to visit congressmen and bureaucrats. The lobbying effort cannot succeed without the participation of industry executives, stresses Yoffie.

Although it may be small by legislative standards, the U.S. disk drive industry does have one advantage in its future lobbying efforts: George Scalise's Washington contacts, cultivated during his years as a semiconductor activist. "It took him a long time to build access to high-level people," says Yoffie. "And all of that effort will not have to be replicated."

But before winning the concessions from Washington, George Scalise and his subcommittee will have to convince his fellow disk drive makers to join them. Given the conflicting interests and objectives of disk drive makers, this may be his toughest challenge of all. ☐

Lifetime costs edge out MIPS in sales pitches

"Cost of ownership" is the new computer marketing watchword as hardware prices fall below 30% of total system costs

BY CAMILA CHAVES CORTES

Look at the full-page auto ads in your Sunday newspaper; the sticker prices always jump out in bold type. Check out the test-drive data in the car magazines and you're sure to see the zero-to-60 mph times prominently listed too.

It used to be that way with big computers. Fifteen years ago, system purchases were based on price, and vendors' marketing strategies involved little more than quotes that came in under the competition's. A decade ago, vendors shifted tactics some, pitching the performance that users would get for their dollar.

But increasingly, savvy computer customers are forcing those old notions to change. It's no longer enough to peddle dhrystones and MIPS; today the emphasis is on lifetime costs. With good reason: at least one market researcher indicates that hardware costs (for hardware used exclusively for network interfacing) can be as little as 25% of the cost of computer-network ownership over five years.

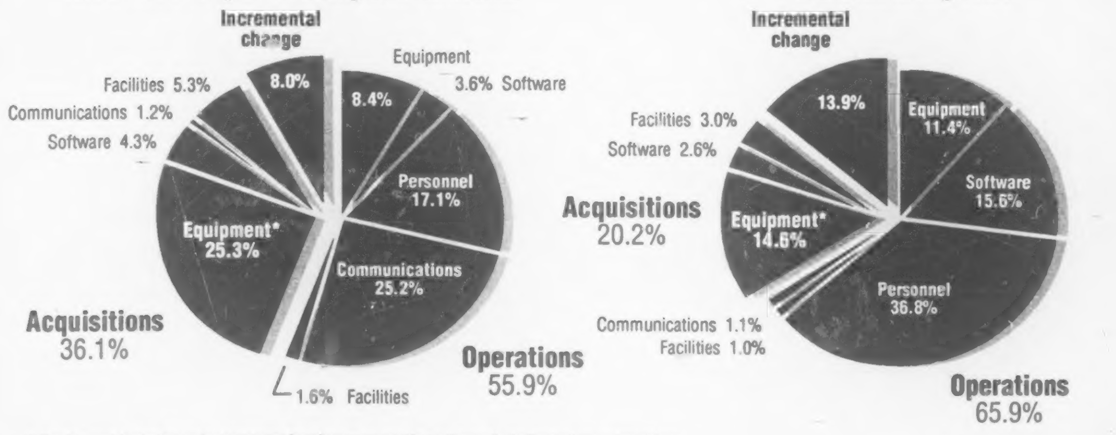
Consequently, big computer makers like Digital Equipment Corp., Hewlett-Packard Co., IBM and Wang Laboratories Inc. are tailoring their marketing strategies to talk cost of ownership (CO). Says Rene Martinez, manager of financial marketing in DEC's U.S. sales support group: "We would like to make CO the way to see the cost of computing." And Herb Oscher, director of product marketing at Data General Corp., confirms that he will continue to use CO studies as his major marketing strategy: "For 1988 and 1989, we plan our CO to be 20% to 40% below our competitors' during a five-year period," he says.

CO means taking into account the cost of staffing the computers; the cost of running the physical facilities — the computer rooms with their heating and ventilating and power needs; the network communications costs; the maintenance charges; and even the cost of fax facilities and voice processing.

The issue is a hot one as the market for midrange computers tightens, forcing vendors into fiercer competition. Market watchers at Wall Street investment brokerage First Boston Corp. point to zero domestic growth in the minicomputer sector, and not much more than 10% internationally for next year; and for 1989, net in-

Equipment purchase is only a fraction of total computer cost-of-ownership

Percentage of total computer network costs over five years



* Equipment includes only computer hardware or portions thereof, dedicated to networking

Source: Index Group Inc.

come is expected to dip to 9.6% of sales even for industry powerhouse Digital Equipment Corp., according to First Boston.

And lifetime cost is more topical as it becomes apparent that staffing payroll and network charges are a growing proportion of total CO. The Sierra Group, a Tempe, Arizona-based market researcher, points out that as hardware prices — acquisition, maintenance charges, minus the expected residual at the end of the equipment's useful life — come down, the future maintenance costs are as significant as buying the machine today.

There's some evidence to suggest that CO feedback may prove valuable to vendors too, isolating cost spikes that can be relayed back to production teams or software development engineers. It is invaluable as input for product pricing, too. But one aspect is clear: it can cost plenty to find and pitch CO advantages.

Wang, which aims to compete with DEC and IBM on initial price-performance and on CO over three years, takes its CO studies seriously. After data-crunching through what-if analyses, the company puts about 150 of the involved employees together to work out CO.

Wang then devotes a team of six or seven people, plus some systems people, to develop the CO picture based on internal costs and the desired profitability. Then the team factors in competitive pricing data and matches it to its costs to arrive at a conclusion the marketing people can live with.

But CO is by no means the perfect yardstick. "The cost of computing is not really known; it's a big mystery. We are finding that a lot of the CO in a system has been hidden because very few accounting methods take all the factors into consideration," admits DEC's Martinez. It gets tricky when data centers, telecommunications facilities and voice-systems departments all have different budgets. And it's tough to make apples-to-apples comparisons of computers when a DEC VAX might be working a database while an IBM System 36 tackles spreadsheets, and when operating systems remain so diverse.

And vendors can still tilt the figures in their favor. "You will see different CO studies come out from vendors based upon their strength," according to Lane Nonenberg, Hewlett-Packard's vice president for support.

A lot of CO data comes from comparative studies done on contract by researchers like the Sierra Group or the Cambridge, Massachusetts-based Index Group. A custom report prepared early this year for DEC by another researcher, Computer Economics Inc. of Carlsbad, Calif., showed — not surprisingly — that typical midrange DEC models such as the VAX 11/785 and VAX 8200 required an average of 2.6 fewer staff to run each year than IBM machines such as the 4331, 4341 and System/38s — a potential cost gap of almost $75,000 annually. Too few of Big Blue's new 9370 sites were operational to be included in the study.

In another report, the Sierra Group addresses IBM's June 1988 cuts in software pricing for the 9370, pointing out that those cuts could trim up to 12% off the cost of operation of a 9370 over five years.

Computer vendors can still tilt the cost-of-ownership data in their favor

But many computer vendors supplement the market researchers' findings with their own studies. Wang, for instance, uses the Sierra Group reports, and Wang performs additional competitive analysis and validations of its data to obtain results that are as timely as possible. At Texas Instruments Inc., it's the same story: the company's computer-systems operation factors in data from the industry watchers, but relies heavily on its own analyses of competitors' pricing structures. Says Wendell Harrison, director of industry marketing: "By the time you get your hands on a market research report, your competitors would have a product out."

Distorted pricing

TI's Harrison raises an interesting issue: how to define CO when different channels of distribution can distort pricing. The more value the VARs add to the computer system, the more difficult it becomes for the computer manufacturer to figure the CO. Says Harrison: "We can't tell our resellers what they should sell their product for, and what price the market will bear."

Some computer executives see more scrutiny of the number of staff it takes to make a computer network work. In the future, says HP's Nonenberg, "One will see staffing as a significant part of CO because the cost of staffing is going up and the price of machines is coming down." Some claim that day is already here: a study by the Index Group shows personnel costs as high as 36% of lifetime operating costs for computer networks in manufacturing sites.

The report prepared by Computer Economics for DEC claims that operating systems have considerable sway in staffing levels. It maintains that while IBM sites using DOS/VSE require only 30% more staff than comparable DEC VAX/VME sites, those using IBM's MVS/XA system could call for over six times the staff. For many users, that's a price they're prepared to pay in return for the sophisticated I/O and memory management capabilities offered by MVS, and for the flexibility to handle complex environments like multiple databases or on-line transaction processing that the IBM operating systems offer.

Traditionally, IBM in most cases charges more for hardware, and in some cases, for software; but less for maintenance and support. Digital's strategy is low hardware prices, but higher charges for maintenance and support. DEC recently displayed that tendency by requiring customers to pay for a previously free one-year warranty program, a move that could add the equivalent of 6% to 9% of the computer's purchase price to total systems costs.

But the perception picked up by computer-industry analysts is that DEC's action represents a 6% to 9% price increase — and in the real world, where psychology plays just as important a role as rational fact, perception counts. While the computer vendors' use of CO as a marketing tool may bring new information to potential buyers, it's also creating a bit more confusion. Concedes one computer marketing chief: "CO analysis will not force anyone to buy from us or from someone else; it is just another way of comparing data." ☐

Taking the wraps off

The technologies of the 1990s

BY ANNE KNOWLES

Imagine that you are in your office when the phone rings. On the other end is your Japanese joint venture partner calling from the company's manufacturing facility in Osaka, Japan. The call is urgent. A glitch in a plant floor controller is holding up the day's production. But there is another problem, a seemingly insurmountable one. Your Japanese caller speaks just enough English to convey the immediacy of the situation but not enough to highlight its details. And you speak just enough Japanese to buy a newspaper in downtown Tokyo.

What do you do? Go down the hall to get that engineer you sent to Osaka last year to set up the plant operation? Grab your Japanese-English dictionary? Or, worse yet, ask for a call back when the problem is solved?

By the year 2000, technology permitting, you may not have a dilemma. You may be able to speak English into your phone while your Japanese caller listens in Japanese. It all depends upon a number of technologies, including speech recognition which enables a computer to act upon the input of speech in the same way it reacts to commands typed into a keyboard.

On the way to a translating telephone, though, speech recognition and evolving technologies like it will find commercial applications. Sometime in the 1990s, industry experts concur, commercially available microprocessors will be capable of 100 million instructions per second (MIPS); desktop computers running several hundred MIPS will be sold for under $10,000; and floppy disks will be as small as one inch in diameter.

Within the next decade, three-dimensional ICs and superconductors may step out of the research labs into the marketplace; voice-and-data communications links based on the Integrated Services Digital Network standard (ISDN) and X-ray lithography for IC production may become commonplace, according to a survey conducted by ELECTRONIC BUSINESS (see accompanying story).

The survey asked 1,500 heads of R&D and engineering in electronics companies what they consider to be the emerging technologies that will make a significant commercial contribution to the electronics industry in the years 1995 to 2000. Over 423 responded; in the semiconductor category, 67% put their money on optical circuitry; in materials, superconductors got three-quarters of the respondents' votes; and in computer peripherals, over 82% ticked erasable optical disk drives.

Today, a lot of R&D muscle is behind the push to bring such technologies to market tomorrow. According to

Greg Couch

the National Science Foundation, U.S. electronics firms spent over $20 billion on R&D in 1986. According to ELECTRONIC BUSINESS, the top 100 R&D spenders in the electronics industry accounted for $13 billion of that, and for $15.8 billion in R&D expenditures last year. [ELECTRONIC BUSINESS, Sept. 1, 1988, p62.] On the average, electronics firms spent 8.6% of their revenue on R&D.

Deciding which of tomorrow's technologies to back is a critical step for the vice president for R&D helping to give his or her company the edge into the next decade. For example, too many resources devoted to, say, superconductivity research, may dull a computer firm's technology advantage in vertical magnetic recording. Top-notch R&D is crucial for "us to be a global competitor and manufacturer and for the U.S. to maintain its standard of living," says Gene Connor, vice president for manufacturing and technology at Advanced Micro Devices Inc., which spent a phenomenal 24.9% of revenue on R&D last year.

But Connor and others question how effectively R&D dollars are spent in the United States. Connor is concerned that not enough emphasis is placed on development and the quick turnaround of "usable and salable products." Richard A. Reynolds, director of the defense sciences office at the Defense Advanced Research Project Agency (DARPA), says that in material research, for example, the Japanese effort is much larger than in the United States. In addition, says Reynolds, "in Japan about 90% of R&D is industry R&D and about 10% is done at universities. In the U.S., probably the exact opposite is true." That implies, says Reynolds, that the fruits of Japanese R&D are transferred to the commercial market quicker than in the United States.

Electronics industry R&D funding

Industrial R&D spending by Standard Industrial Classification codes* for the latest available year — 1986 ($ millions)

	Total	Government funded
Electronic components including semiconductors (SIC 367)	$2,537	$520
Office and computing equipment including peripherals (SIC 357)	$6,876	$1,152 **
Communications equipment (SIC 366)	$5,155	$3,593
Total	**$14,568**	**$5,265**

* The National Science Foundation (NSF) does not break out spending on software. Software R&D is included in each of the equipment categories to which it applies.

** Government funded industrial R&D for office computing equipment is a NSF approximation. The NSF survey reported $1,536 million in government funded industrial R&D for SIC 35, which includes equipment other than computers and peripherals.

Source: National Science Foundation

So, what is the solution? Opinions differ. According to Kumar Patel, executive director of the research, material science, engineering and academic affairs division of AT&T's Bell Laboratories, large institutions clearly have the most advantages. He points out that the R&D competition — Japan's Fujitsu Ltd., Hitachi Ltd. and others — is gigantic. "If large institutions [in the United States] are not able to provide the innovation we need, we will not succeed," Patel states flatly. Start-ups, says Patel, sometimes drain large R&D labs of their best talent. "While we don't want to squelch the frontier type of mentality here in the U.S., we also don't want to sap the energy of large institutions."

One solution used by Xerox Corp., which spent $722 million on R&D last year and is well-known for its research facilities, is to spin out some of its R&D efforts into start-ups. Xerox has spun off six such companies, five of which they have an equity interest in. "The scuttlebutt in the industry," concedes Patel, "is that their approach seems to be working."

Others, like AMD's Connor, think that suppliers and customers will need to cooperate in development more in the coming decade. Some think that Sematech, the recently organized semiconductor industry consortium, and joint efforts like it may be the answer. "Will Sematech and other consortiums work?" asks William J. Spencer, vice president, corporate research group at Xerox. It is hard to predict, says Spencer, "but they are absolutely neccessary in order for us to compete with Japan."

Money and man power, though, do not always guarantee results. Some technologies will advance if enough elbow grease is applied to them. Others, like neural network computers and software, require new ways of thinking that money cannot buy. The seed for those, experts warn, may come from one or two brilliant minds.

"Real conceptual advances," says Bell Labs' Patel, "come from an individual's brain."

The next decade

Expected breakthroughs in superconductivity, for example, are difficult to pin down. The NSF estimates that the United States and Japan combined are currently spending over $500 million a year on superconductivity R&D. Industry heavyweights like Bell Labs and IBM in the United States and Hitachi and Matsushita Electric Industrial Co. in Japan, and universities on both sides of the Pacific are together devoting nearly 2,000 engineers to the problem. And while many believe a breakthrough in high-temperature superconductors will occur within the next decade, others are not so sure. "It depends upon what the physics tell us," says Ray Waddoups, Motorola Inc. vice president and director of research and development at the company's government electronics group. "The physics have not been sufficiently defined to tell us what the technology will do."

The topic of advanced computer architectures is another area in which experts tread with caution. Parallel processors — computers that tie together hundreds and even thousands of processors that work in unison — are being built today. "But the difficult problem," says Bell Labs' Patel, "is [creating] the appropriate algorithms that can write a language to take advantage of parallel processing." The technology, says Patel, "is still lacking a concept that allows us to think very differently than one process at a time."

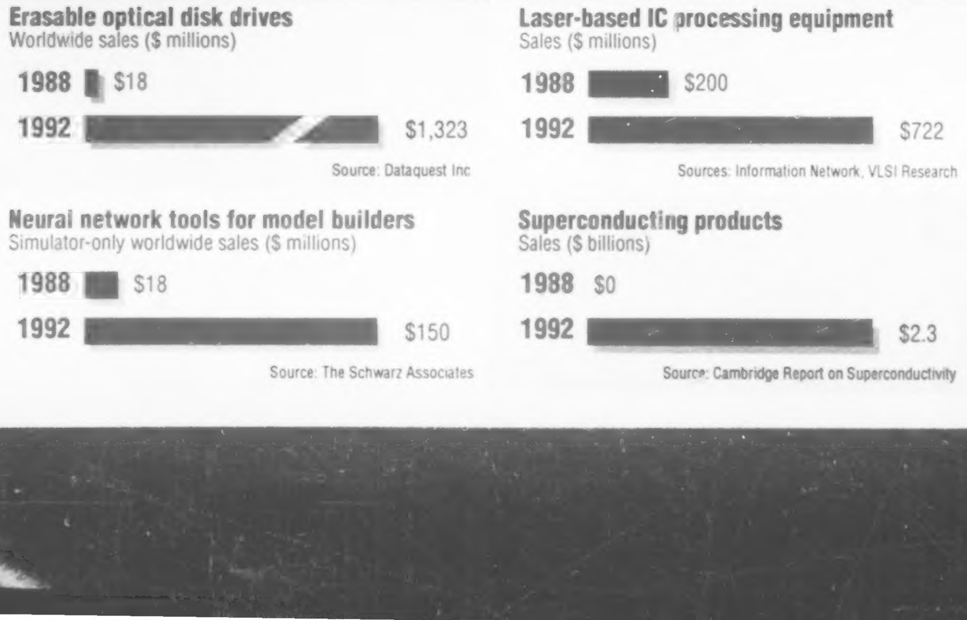
Neural network computers, designed in some way to mimic the biological brain, are suffering from the same problem. Today neural networks are hard-wired through trial and error, says Patel, because we still don't understand how they work. But their expertise at certain specific problems makes neural network computers very appealing. They are proficient at what Patel calls optimization problems — like image and voice recognition — for which the goal is to get the best, not the exact, answer quickly.

Industry researchers are understandably wary of predicting the future. "If you say there is no hope, no one will fund your research," says Stewart D. Personick, assistant vice president for the network technology research laboratory at Bell Communications Research Inc. (Bellcore). "And if you hype it and say it will happen on January 1, 2013, they'll put it on their calendar and come after you."

Despite their disclaimers, experts say some technology development is a sure bet. Most observers agree, for example, that existing semiconductor technology still needs to mature. "There is still a lot of evolutionary development needed in mainstream semiconductors like CMOS," says AMD's Connor. He predicts that by the mid-1990s CMOS devices with .5-micron line widths will be produced in volume. And by the end of the decade, says Connor, 0.35-micron ICs will be available. Work in bipolar technology will be ongoing, says Connor, but it will be "squeezed on one end by gallium arsenide when that becomes more cost effective and by CMOS on the other end."

Gallium arsenide (GaAs) ICs will continue to evolve and become used widely in a few applications. But GaAs will be limited to niche applications, says Connor, due to manufacturing and cost issues. He says today GaAs is produced on 4-inch wafers and researchers are investigating a 5-inch variety, whereas CMOS and bipolar technology are already being done on 6-inch and, at IBM,

A sampling of future technology markets



Erasable optical disk drives
Worldwide sales ($ millions)

Source: Dataquest Inc

Laser-based IC processing equipment
Sales ($ millions)

Sources: Information Network, VLSI Research

Neural network tools for model builders
Simulator-only worldwide sales ($ millions)

Source: The Schwarz Associates

Superconducting products
Sales ($ billions)

Source: Cambridge Report on Superconductivity on 8-inch wafers.

In addition, warns Motorola's Waddoups, budget cutbacks at the Department of Defense, which he says is the driving force behind GaAs research, could slow the progress made in that technology.

Because of those factors, and the general purpose nature of existing semiconductor technology, "silicon ICs will continue to dominate," says Xerox's Spencer. "There is another decade-and-a-half of milk in that cow."

Seeing is believing

Optical chips are still a daydream. Optical interconnection within a computer will occur on varying levels, says Joseph W. Goodman, chairman of the electrical engineering department at Stanford University. The most difficult, and furthest out along a technological timeline, is gate-to-gate optical interconnect. "Prospects within this century are very dim," says Goodman. More realizable, within the next 10 years, may be board-to-board optical connections.

Least likely anytime soon, however, is an all-optical digital computer. Replacing all of a machine's electronics with optics, says Goodman, "is furthest from reality." Others are more optimistic; 39.9% of the survey respondents believed optical computers were feasible sometime in the 1990s.

> **"Real conceptual advances come from an individual's brain"**
>
> **Kumar Patel of Bell Labs**

Goodman notes that two industry giants — AT&T and IBM — have decidedly different views on optics. And, contends Goodman, both companies are right. IBM, which sees little future in optics, is correct from its own business viewpoint; general purpose optical computers are unlikely. AT&T, on the other hand, supports optics because of its potential in communications systems.

Bell Labs' Patel expects a boon in such systems. "Within the next 10 years," says Patel, "all switching will be done in optical. The cost of switch-to-switch goes down as the speed goes up."

Probably the most eye-catching optical technology, though, is optical memory. Goodman says that while Japanese stalwarts like Olympus Optical Co. Ltd. and Sony Corp. have done a lot of work in that area, the United States has competitive product. The 30-millisecond access time on Maxtor Corp.'s Tahiti 1 erasable optical disk is faster than Japanese products by a factor of two. It is also capable of holding up to a gigabyte —or 300 volumes of 1,200 pages each — of data.

While the Japanese are gearing up to produce digital audio tape (DAT) in high volume, political issues here in the United States may continue to stand in the technology's way, says Don Lundell, corporate vice president for engineering at Cipher Data Products Inc., a major U.S. tape-drive maker. "DAT is a product whose time has come," says Lundell. It's a high-volume product geared for the low end of the market. But the U.S. record industry is trying to thwart attempts to sell it here because of its ability to reproduce CD ROM without degradation. And the personal computer peripheral market is a much smaller market without the high-capacity needs provided by DAT.

According to Lundell, the auto industry may be deciding DAT's future here, if it chooses to include DAT recorders in its next-generation cars. Ford Motor Co., for example, is currently testing DAT players in its 1988 Lincoln Continentals.

Workgroup computing

All this capacity, bandwidth and power, in addition to a lot of software, will create a desktop very different from today's. Winchester disk drives will use 2.5-inch form factors and laser printers will be available for $200, projects Lundell; desktop computers costing $10,000 will process data at hundreds of MIPS, predicts Xerox's Spencer.

Artificial intelligence, in the form of expert systems, will be increasingly used in common applications, observers agree. This, and brawny hardware, will create what Xerox's Spencer calls "knowledge robots," — friendly computers a user can program daily to do database searches and other tasks.

But most importantly, most of those high-speed desktop machines will be networked together. "In less than 10 years, the number of networked PCs will double," claims Lundell.

Powerful hardware and robust multitasking operating systems, like OS/2 and versions of Unix, will drive software development. Software will take advantage of that brawn in a number of stages, says Edward J. Belove, vice president, corporate research and development at Lotus Development Corp. First, Belove believes existing applications, like Lotus' 1-2-3 spreadsheet, will become more functional. Next, software from different vendors will be integrated and "connected to one another in seamless ways." In turn, packages will talk to one another, says Belove, and vendors will cooperate in their integration.

The third stage, and most formidable goal, will be the creation of workgroup computing. Belove calls it "groupware." It is a step beyond communal word processing. It will entail application packages designed to work on networked PCs that enable groups of people to work together. And, again, it will demand new, as-yet-unknown ways of thinking and working. ☐

nologies Inc., San Jose, in July 1986, based on the company's strategy of designing ASICs for microcomputers and letting somebody else fabricate them. "Two years ago, it was thought that you had to have your own fabrication line," says Stephen G. Woodsum, managing director of Summit Ventures. Despite having bucked this conventional wisdom, Chips eventually went public and in the fiscal year ended June 30, 1988, reported earnings of $1.54 a share, up sharply from the year-earlier $1.01.

Crucial to selecting a technology to back, venture capitalists agree, is accurately assessing the state of the competition. According to Mike Shanahan, a partner in Eastech Management Co., Boston, even a truly innovative technology has "functional competitors" who accomplish the same thing by entirely different means, which is why the price performance of a new technology is critical.

Almost universally stressed by venture capitalists is that judging technology entails evaluating the people behind it. "We do a lot of checks on the folks in the company to establish what work they have done in the past that is related to what they are doing now," reports DuBose Montgomery, partner in Menlo Ventures, Menlo Park. Sequoia Capital backed Convex Computer Corp., a minisupercomputer maker, partly because "The people all had stellar backgrounds; they had designed machines that worked, and they had four-star resumes," according to Moritz.

Pavey prefers entrepreneurs willing to regard the venture capitalist as a partner who will participate in strategic decision-making. "We don't want to control the company, but we do want to be a partner, and if we don't think that relationship is possible, we don't put up the money."

RAY WISE

The changing face of technology in the 1990s

Our readers pick which new technologies will likely develop into commercial products in the 1990s

Believe it or not, it's nearly 1990. The next decade, like the last, promises to change the face of technology in the electronics industry. What evolutionary, revolutionary and plain old amazing technological achievements will occur in the next 10 years? ELECTRONIC BUSINESS surveyed 1,500 vice presidents and directors of technology, engineering and research and development to get a picture of what tomorrow will look like. Respondents listed what they believed to be the most likely technologies that would develop into commercial products in the 1990s.

ELECTRONIC BUSINESS technology survey

What new technologies will likely develop into commercial products from 1995 to 2000? — Percentage of respondents*

Semiconductors	
67.1%	Optical semiconductors
47.2%	Wafer scale integration
41.5%	3-D integrated circuits

Materials	
74.0%	Superconductors
43.3%	Submicron photoresists
37.9%	Polymers with low dielectric and high temperature

Computers	
77.2%	Parallel processing computers
39.9%	Optical computers
36.1%	Neural network computers

Capital equipment	
63.1%	Laser-assisted production
55.7%	Mixed analog/ digital testers
33.0%	X-ray lithography

Peripherals	
82.3%	Erasable optical disks
64.2%	Speech recognition
22.1%	Vertical magnetic recording

Software	
63.4%	Advanced compilers
63.4%	Real-time operating systems
42.9%	Object oriented programming

* Multiple responses

Source: ELECTRONIC BUSINESS

How do venture firms pick a winner? Carefully

They may be attracted to a new technology, but that's not all venture firms will judge a start-up on

The decision to fund a start-up based on its technology is a chancy, complex process that warrants a hefty payback when a winner is picked, venture capitalists say.

The cycle of true innovation that began with the creation of the integrated circuit, progressed to the microprocessor and culminated in the emergence of the microcomputer "made more money for venture capitalists than any other technological wave in history," according to Bob Pavey, a partner in Cleveland-based Morgenthaler Venture and a director of the National Venture Capital Association. Profits generally are substantial when a venture capital firm finances the right company, and, in fact, the investment can appreciate as much as tenfold over five to seven years if it is injected at the start-up stage.

The bumper returns reflect the intricacy and risk of evaluating a technology's potential. "We spend hours upon hours talking to scientists, planning how to harness their technologies to marketable products," says Nissan Boury, managing director of Warburg Pincus Ventures, New York City.

These investors rarely judge a technology unaided, although they screen ideas that are presented to them. Business proposals that pass through this initial gauge are then evaluated with the help of experts outside the venture capital firm.

"We do not hope to understand leading-edge technologies," says Diana H. Frazier, vice president of BancBoston Ventures Inc., a wholly owned subsidiary of Bank of Boston.

Even with outside help, deciding whether to finance technology is "a great, big step into the deep, dark unknown," according to Michael Moritz, a partner in Sequoia Capital, Menlo Park, Calif. "We have to find out how different the proposed technology is from others that are, or will be, available. Only if it is well differentiated will our blood pressure go up."

David S. Lobel, partner in First Century Partners, New York City, etches a sharp distinction between improvements to existing products and technology that creates a whole new class of products, as Apple Computer Inc. accomplished with its microcomputer. Lobel steers clear of "better mousetraps," unless, he says, "the management team is truly superb, because everything has to go right. With true innovation, we have more time and will take more risk with management."

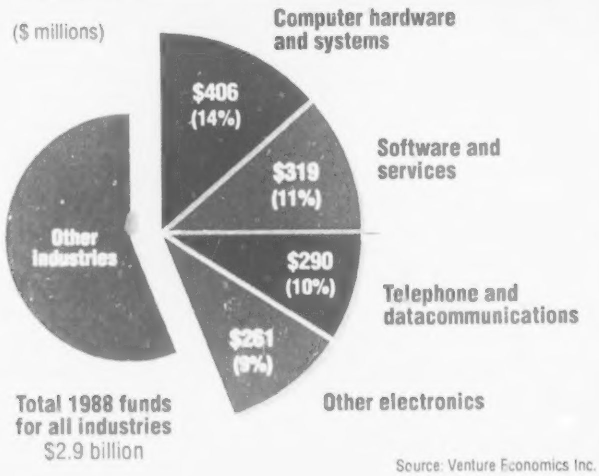
Venture capital often is infused in very early-stage technology. When Sequoia Capital invested in Ultra Network Technologies, San Jose, in December 1986, the company's "blisteringly high-speed LAN for supercomputers and near-supercomputers was still on paper," Moritz reports, and the first product was brought out only weeks ago.

In terms of putting product on the shipping dock, many venture capitalists use a two- to three-year time horizon. "I want to see a working prototype in 12 to 18 months," Lobel notes.

Taking a flier

Sometimes the venture capitalist takes a flier on the innovative strategy of the technology's creators. Summit Ventures, Boston, backed Chips and Tech-

High-tech start-ups attracted nearly half of venture capitalists' funds in 1987



Source: Venture Economics Inc.

Start-up success? It *can* be done without venture funds

Rich aunts, big corporate partners and even Uncle Sam get plenty of new firms off to good starts — but they can't always match those old VC connections

BY VALERIE RICE

Starting a company without venture capital used to mean it was doomed to failure. In today's market, that's no longer true.

With surprising frequency, start-up companies are finding alternate ways to finance their growth, and they are succeeding in the face of some of the biggest odds.

For budding entrepreneurs either too stubborn or too far ahead of their time to go the venture capital route, the road is rocky, but the payoffs can be big.

Roughly 25% of the 150 semiconductor companies started in the last 10 years have not used venture capital funding, according to a survey done by market research firm Dataquest Inc. This trend is not just limited to semiconductors; high-technology companies from software to peripherals are also looking for different options.

From foreign stock markets to the federal government to corporate partners, wealthy private investors and even customers, alternate financing opportunities have multiplied over the past few years. Although venture funding has not disappeared, it is more difficult to get, making nontraditional funding sources even more attractive.

Citing "control of our destiny" as the biggest reason for bypassing venture capital, executives at companies such as California Micro Devices Inc., Cumulus Technology Corp., International CMOS Technology Inc., Orbit Semiconductor Inc., Pantronix Corp. and even "old-timer" Siliconix Inc., entered the market without the venture seal of approval, and actually prospered.

But one doesn't scoff at conventional wisdom without a price, and funding a company without the deep pockets of a venture capitalist brings its own share of heartache.

Nothing ventured, something lost

When companies forgo venture funding, what do they give up?

In the most simplistic terms, big name venture capital spells p-r-e-s-t-i-g-e.

Venture capitalists provide management experience, a financial safety net, and perhaps even most importantly, contacts. If a company receives money from one of the top five high-tech funds, it also nets some reflected glory, basking in the glow of an L.J. Sevin or a Fred Adler.

And, although prestige is an intangible, to those who have benefited from it, it is quite real.

Consider the case of Cypress Semiconductor's founder T.J. Rodgers, an acknowledged venture cheerleader. Although Rodgers has an MBA from Stanford University, he claims his venture people have kept him from making numerous bad decisions.

Just being connected with these top-flight venture people has had its own rewards — like staying out of court. Cypress, which is swamped with legal battles today, could have been overwhelmed by legal battles

On a Rolls: Rejected by several VCs, California Micro Devices' chairman Chan Desaigoudar used a funding strategy that gives him 51% of his company

Christopher Springmann

when it began, and Rodgers says only the connections of venture capitalist L.J. Sevin and his team of lawyers kept him out of five major lawsuits over the past few years. On the basis of recommendations from the same venture firm, Cypress received the largest loan Bank of America ever made to a start-up — $9 million.

These are advantages it is hard to disregard, as California Micro Devices Inc.'s chairman Chan Desaigoudar would agree. During his first rocky year of bootstrap financing, Desaigoudar hit a period where he was $30,000 short for payroll, and had to go to a customer to borrow the money against future product. He made payroll then, and has taken the company from virtually nothing to an estimated $120 million at the end of this year.

Desaigoudar acknowledges, however, that his perceived lack of backing has done him some damage in the marketplace, and that his company does lose sales to competition purely on that basis.

Other start-ups hit the venture capital wall when trying to find enough money to invest in future growth. Chip start-up Macronix Inc. is now considering bringing venture capitalists into the company for the first time because the money to expand operations just doesn't exist, according to president Paul Lui. "We want to grow our business in the United States," he says. "We need more money. We can't get enough profit to grow to the next stage."

Executives at Cumulus Technology acknowledge the risks, but believe that venture capital is unnecessary for them. "There is a limit to the amount of cash we can get," admits finance vice president Peter Henderson. "As long as we are at the mercy of the vagaries of the market, that may stunt our growth."

But sometimes, when things go sour in the market, the only answer is venture capital, at least for Unix software house Unify Corp., Sacramento, Calif. Although Unify began life with private funding, it lost its way as the Unix market fragmented, says president David Saykally, and venture funds were the only option. The advantages of management guidance and connections far outweigh the disadvantages, he says.

Despite the downsides, some executives would rather risk falling flat on their faces than give away the majority of their company for very little money today.

Controlling destiny

"Profit is the motive," declares Desaigoudar, of his decision to privately fund his semiconductor company. "If I make a mistake I have no one to blame but myself."

Stanley Wang, founder and president of Pantronix Corp., a test, assembly and packaging house, says that his route of private investors has allowed him to "maintain my independence. We have no outside influences here. There is no pressure to compromise. With a venture capitalist, 100% growth is too slow. This way we can maintain control."

Chips and Technologies Inc. president and chief executive Gordon Campbell says that if he had gone the venture route (he claims to have been vetoed by 60 VCs), ". . . we would own less of the company and not have as much control." Campbell so values the control factor that he considered a leveraged buyout of Chips to take the company private again. Even though right now he says "it would be a mistake to reposition us," he has not forgotten the skeptical reception the market gave him.

Although most of these maverick executives would argue that no price was too high to stay free of the clutches of the "vulture capitalists," there are trade-offs to be made, depending on the funding source. Although generally speaking, founders of privately funded start-ups do better financially than those at a venture start-up, even that is not always true. Essentially, there is no free financing out there, only greater or lesser evils.

Corporate partnering is a popular solution to the funding dilemma, and one in which every party can be a winner. Cypress is the sole investor in bipolar start-up Aspen Technologies Inc., and according to Rodgers, it is a mutually agreeable relationship, in which Cypress gets technology access and Aspen can get management help.

But the relationship must be synergistic, warns Siliconix president Richard Lee. Siliconix's major shareholder is Westinghouse Corp., which has been trying to sell its shares in the company now for several years.

Christopher Springmann

Chips chief Gordon Campbell says clowning around with venture capital would have cost him the control he so values

Lee says he'll "be glad when that era [the sale] is over. It's important to have happy shareholders."

Orbit Semiconductor Inc. is fully owned now by Orbit Instruments Inc., says president Gary Kennedy, because the instruments company was the only one which was interested in funding a foundry operation. Kennedy characterizes the relationship as strong, although he notes that none of the semiconductor founding team own any part of the company.

When Chips looked for funding, it ended up with a mix of private investors and money from four Japanese firms, a combination which Campbell claims was just right to get the company over the initial hurdles.

The fact that Campbell went to Asia to get funding is not surprising. Japan, in particular, has accrued a substantial surplus of capital, and has been plowing much of it into U.S. investments, notably in real estate.

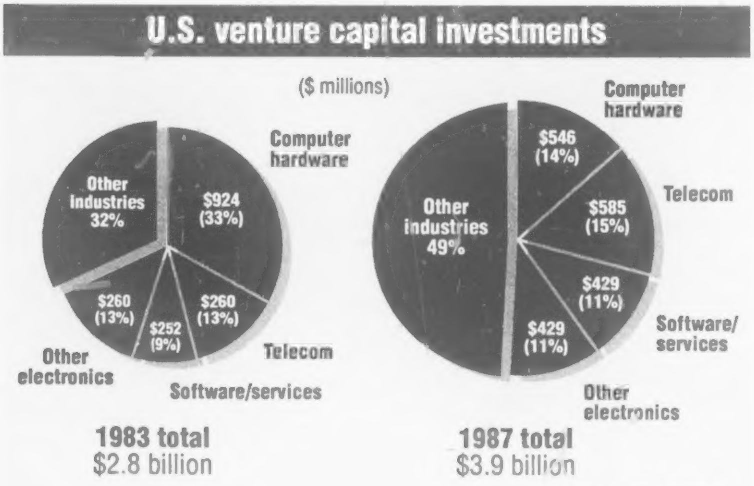
Both Pantronix and Macronix have private and corporate investors from Asia, and Lui explains that money is easier to come by over there. "They don't make you jump through the hoops that you have to over here. If they like your business plan and they believe in you, they give you the money. There isn't the due diligence over there."

But the foreign money is not just in Asia. Favorable exchange rates make European money go further in the United States right now, as Cumulus Technology Corp. discovered.

Having run out of stray aunts and uncles to invest in the company, and feeling that management was experienced enough to do without VC advice, the founders went to the Vancouver brokerage market for funding and a public offering, says Henderson. Although the market over there has a "gloryhole mentality," he says, the company was fortunate in getting a longer term deal. The Vancouver connections brought introductions to the European market, and now Cumulus has some of the largest banks in the world as investors.

25% of the 150 chip makers started in the last decade didn't use venture funding

For a truly unusual funding story, there is none better than Desaigoudar's story of struggling to acquire a very small and unprofitable design house. Turned down by several VCs, which, he says, "couldn't see my vision or my niche," the California Micro Devices chief turned to the Small Business Administration (SBA) for a loan. "After all, I had a small business," he says. That, combined with a line of credit from Bank of America, got him going. The taste of success must be very sweet for Desaigoudar — thanks to this funding arrangement, he owns 51% of the company.



Source: Venture Economics

Electronics and computer companies are increasingly being forced to find alternatives to venture capital funding

IPOs and the FUD factor

The most difficult period in a privately funded start-up's life comes at the time of the initial public offering. Or maybe the issue might be better stated as: "To go public, or not to go public?"

With a venture funded company, that is not a question. With the connections available, and the elusive prestige factor, venture funded companies find an easy time of it, and their stock goes out at a higher price.

Yet, private companies, must struggle to get a share of the broker's mind, wind their way through the complex corridors of the Securities and Exchange Commission, and hope for enough momentum in the market to ensure a respectable stock price.

"There is some merit to having a venture capitalist in your company," Macronix's Lui allows. "They can help you to go public and can give you the insight to do it right."

Ready Systems Inc. president James Ready notes that as his company considers an IPO next year, he is grateful for his venture capitalists. "There is such a strong venture capital infrastructure, " he says. "They can network you from your inception to going public. It gives you tremendous advantages."

Campbell offers the contrarian viewpoint. He admits that Chips' initial stock price of $5 was "way undervalued" but argues that's an advantage in the bearish technology stock market that exists today. "We have never gone underwater," he claims, "and that cannot be said of [some others], which went out at higher prices."

For Wang at Pantronix, the real issue surrounding the IPO is the short-term nature of the American stock market — and of the venture community. Wang views an IPO only as a means to an end, not the end in itself, and believes that by trying to squeeze every last cent out of the company in short-term profits, the long-term health of the company will be jeopardized. ☐

Korean PC firms make impressive inroads here

But as wages and the value of the won rise, profits are falling. Korean electronics giants realize that to survive they must offer more than just low prices

BY JOHN McCREADIE

The South Korean electronics industry is still booming in the United States, and from all indications will continue to grow. Korean electronics giants are now focusing more on PC sales, hoping to make new inroads by expanding current product lines and increasing their market share in this country.

In less than two years, companies such as Daewoo, Goldstar, Hyosung, Hyundai and Samsung have grabbed increasing shares of the U.S. market. With PCs based on Intel Corp.'s 8086/88 chip, the Koreans have firmly entrenched themselves as contenders in the IBM-compatible PC arena. Korean PC exports last year jumped to $260 million from $60 million two years earlier, according to U.S. Department of Commerce figures. During the first half of 1988, the Commerce Department reports, Korea shipped $172 million worth of PCs to the United States.

InfoCorp, a market research company based in San Jose, ranks Daewoo third for 8086/88 units consumed in the United States — after IBM and Tandy Corp. Korean conglomerate Hyundai is filling the 10th slot in the U.S. market. In the worldwide arena, Daewoo now ranks eighth, according to InfoCorp's 1988 estimates. As a result of this rapid growth, Korean companies like Daewoo and Hyundai are facing serious questions on how to keep the sales ball rolling: questions concerning name recognition, marketing strategies and product support systems are at the top of their lists.

Also, concerns that a steadily appreciating Korean won could reduce American purchases of their products by making them more expensive may be keeping Korean executives awake at night. "The Korean government is expecting appreciation of about 12% to 13% [this year], but the U.S. is pressuring them to get up to 15%," says Wan Hee Kim, an expert on Korea and former chairman of the Electronic Industries Association of Korea. In addition, the United States has threatened trade sanctions if South Korea fails to open its domestic import doors wider, allowing for more trade from the West.

Traditionally, the Korean government has slapped prohibitive tariffs on imports, most notably on foreign auto imports. It's estimated that 95% of the cars on Korean roads are manufactured locally. But these restrictions have eased greatly, Kim contends. "Koreans are now willing to import technology and products from the U.S.," he says. "America is a large market and they want to keep America happy."

Despite the threat of trade sanctions, all signs indicate South Korean growth is strong in the U.S. electronics market. For example, Hyundai Electronics America recently signed an agreement to supply a line of PC systems to Software City Inc., a New Jersey-based seller of Zenith Electronics Corp. products. "Once we hit Hyundai, it was pretty much what we were looking for," says Dennis Tully, director of hardware purchasing for

Hyundai's H.S. Shin: His company has made a "strict commitment" to focus distribution primarily on computer speciality stores

Cindy Charles

Hyosung's Jung Lee: "The hardest part about competing in the United States is building a brand name in the marketplace"

Cindy Charles

Software City. "Their whole product line is quality machinery with a low price."

At year-end, the Samsung Group will merge its consumer and industrial operations, Samsung Electronics and Samsung Semiconductor and Telecommunications, hoping the move will make it one of the top five electronics firms in the world by 1995. And under an OEM agreement, Hyosung Computer Co. will supply a large quantity of XT and AT IBM clones to Vendex Technologies Inc. of Great Neck, N.Y.

Overall, the success of Korean IBM clones in this country has been attributed to the Koreans' ability to undersell competitors. But as wages for Korean electronics workers continue to rise rapidly — 15% to 18% this year alone — the Korean companies realize they must carve out niches, for quality along with name recognition.

"The hardest part about competing in the U.S. is building a brand name in the marketplace," says Jung Lee, Hyosung marketing director. The biggest trick for many of these companies, however, will be establishing their own identities while maintaining their OEM contract customers.

Name recognition

The 1988 Summer Olympics gave many Korean firms a chance to make themselves known. Samsung Electronics advertised heavily during the games, highlighting efforts to make its products a household name. By 1991, the South Korean conglomerate hopes that 55% of its electronics product line will carry the Samsung name, an increase of 15% from today's exports. And Goldstar Electronics, focusing primarily on OEMs, is talking seriously about starting a brand-name line of Goldstar PCs sometime in 1989.

All the giants hope the name recognition they have in other markets will carry over into the PC arena. Hyundai, banking on the name recognition established by the success of the Excel automobile in this country, has been supplying dealers and value-added resellers with IBM-compatibles for the past year. Likewise, Goldstar Technology Inc., a subsidiary of the Lucky-Goldstar Group, the oldest Korean company in electronics, is relying heavily on its name in televisions and VCRs, as is Samsung.

But such expansion could backfire as companies introduce products that compete directly with the companies with which they have OEM agreements. Says Goldstar vice president for sales and marketing Jay H. Lim: "Most OEM customers prefer that we don't sell products with the Goldstar name." But other South Korean companies say their product line is broad enough to allow them to do both. Hyosung America, currently doing 50% OEM business and 50% with its Maxar PC line, plans to expand both areas, says Lee.

As these companies become more established and recognized in the U.S., the need for a solid distribution game plan will become crucial for their survival. Hyundai has made a "strict commitment" to focus primarily on computer speciality stores. Executives believe that their marketing strategy, selling direct to dealers and VARs, will give them greater distribution control and longevity in the market. "Our marketing decisions are made for the long term," says Hyundai's national sales manager H.S. Shin. Although Hyundai will continue with OEM agreements, such as manufacturing a workstation for Sun Microsystems Inc., they will not make any label-switching agreements, Shin says.

Last year, Korean PC exports to the U.S. jumped to $260 million from $60 million in '85

Too soon to tell

But is Hyundai's strategy paying off? Most analysts agree that it's too early to tell. Sales in the first part of the year were strong: 6,200 PCs sold in the United States during the first quarter, and 12,400 units in the second quarter, according to Storeboard, a Dallas-based market research firm that surveys retail stores across the country. In June, Hyundai sold 6,400 of the 235,000 PCs sold nationwide, giving them a 2.7% share of the market. In July, however, they dropped to a 1.7% market share, a sharp decline of 42%. Storeboard president JoeAnn Stahel attributes this decrease to a substantial price drop in July by mass merchant competitors, Target Stores and K Mart department stores among them. "If Hyundai continues to slip, it's simply because of their market strategy," Stahel says.

Leading Edge Hardware Products Inc. of Canton, Mass., whose PCs are manufactured by Daewoo Telecommunications Company Ltd., also experienced a similar market share decline. Storeboard reports Leading Edge had a 2.2% market share in June and a 1.9% share in July. But this may not be just an isolated drop for Leading Edge. Several analysts note Leading Edge sales have taken a turn for the worse. According to market research by International Data Corp., Leading Edge shipped 190,000 PCs into the United States during 1986 and only 140,000 in 1987.

Reasons for this drop, according to industry observers, are that many retailers are less than satisfied with Leading Edge's ability to make timely shipments, as well as their demands to have deliveries paid in cash and in advance. K.H. Lee, general manager of Daewoo Telecom in Boston, speculates that Leading Edge seems to be giving large outlets, priority shipments and not meeting the demands of the smaller retailers. "We don't like that, but we don't have any right to do anything about it," says Lee.

Leading Edge, however, says its products currently have strong sales, helped by a new program to serve better its smaller dealers. "We are selling them as fast as they can make them," says Buddy Carp, chief operating officer for Leading Edge.

Some South Korean companies have begun shielding themselves in case sales sag in their current market segments by carefully expanding their market niche. Take Hyundai, for example. It has recently begun an effort to penetrate its PCs into vertical markets and among corporate accounts. And Cordata Technologies Inc., a subsidiary of Daewoo Electronics Company Ltd., has introduced the WPC Bridge computer that will run both Apple II and IBM software, a product which they believe will give them considerable clout in the education segment of the market.

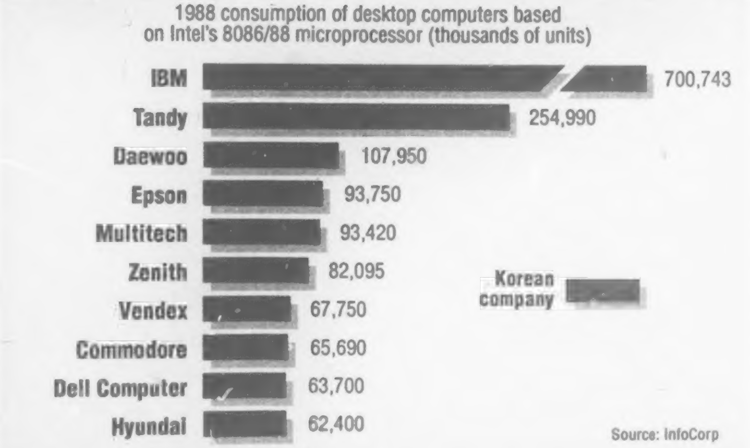
Opportunity for distributors

One of the areas all Korean companies are paying particular attention to is product support. As wages in Korea rise, companies can no longer rely on cost factors alone to sell their products. More and more of these companies are opening avenues for distributors and dealers to get after-sales service. "As products expand, we're going to move in to reinforce and strengthen our relationship within the market channels," says Hyosung's Lee.

The giants hope name recognition in other markets will help sell the PCs

If their market strategies pay off, the Koreans could become even bigger players in the high-tech computer game. Korea has already produced its own supermini, through technology provided by Tolerant Systems Inc. of San Jose, for its own national market. The project was a collaboration of the Electronics and Telecommunications Research Institute of Korea and the big four —Daewoo, Goldstar, Hyundai and Samsung. Through a similar combined effort, the South Koreans have a 4-megabit DRAM geared for production early next year. More and more of these companies are reinvesting their profits into R&D, but dollar amounts for the electronics branches of these conglomerates are not available. "I can tell you we are emphasizing R&D research and it will grow in coming years," says Hyundai's Shin.

U.S. consumption of low-end PCs


1988 consumption of desktop computers based on Intel's 8086/88 microprocessor (thousands of units)

Source: InfoCorp

Yet the South Koreans are not limiting themselves to expansion in the United States. They have been actively increasing business with Eastern Europe and Communist countries such as China and the Soviet Union. "They have exported about $200 million worth of electronics products to these markets so far this year," says Korean electronics expert Kim. "And they expect a very large increase in trade with Communist and Third World countries."

And still more Korean electronics companies are setting up shop here in the United States. As a result of Hyundai canceling its distributor arrangements with Blue Chip Electronics of Chandler, Ariz., in order to sell its product direct to dealers, Trigem Computer Corp., another Korean conglomerate, stepped in and took over Blue Chip's manufacturing. Trigem, which formerly made models sold under Computerland's private label, now plans to diversify its products from PCs to technical workstations. Oriental Precision Co. (OPC) is now marketing a PC using the OPC name and also expanding into hard disk drive manufacturing. And South Korea's $5 billion Ssangyong conglomerate will expand on its software business and begin making PCs.

Meanwhile, as South Korean companies wrestle with the problems of being as recognizable in the United States as IBM and Tandy, they will have to deal with the same issues facing all IBM clone makers: possible lawsuits. With IBM now asking for royalties on its AT, XT and PS/2 clones, it will be interesting to see what effect this will have on Korean market strategies. Analysts say as little as 5% royalties could be devastating to South Korean PC makers because they work on such narrow profit margins. But most Korean officials are taking a wait-and-see attitude. Says Goldstar's Lim: "Probably we should talk to IBM later, but not yet." ☐

U.S. computer firms go shopping in Taiwan

Just about every major computer company does its shopping in Taiwan. IBM spent $278 million there last year. Here's why

BY PHILIP LIU

Taiwan is becoming an increasingly important source of parts for foreign computer firms. In fact, for many U.S. companies like IBM, Taiwan is now second only to Japan in terms of Asia sourcing. Cheaper prices aside, Taiwan also boasts substantial technical expertise enabling design-to-production leadtimes to be shortened by as much as one third. But quality and a lack of long-term business planning still remain major obstacles.

Taiwan's exports of information processing products — including microcomputers, disk drives, printers, terminals, keyboards, and other peripherals and components — reached $3.7 billion last year, roughly 96% of the local industry's total output, according to the Information Industry Institute. Of that $3.7 billion figure, 41% was purchased by foreign computer companies from local firms on an OEM basis. Another 39% was shipped by foreign-invested firms manufacturing in Taiwan [see accompanying chart].

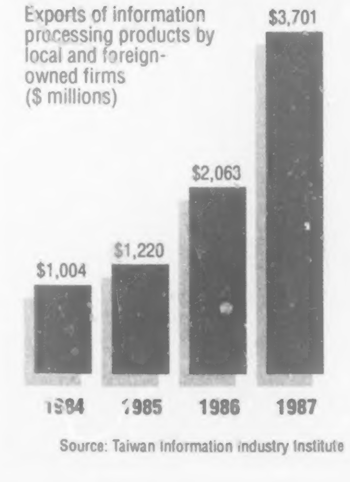
Big Blue's shopping spree

Most leading multinational computer firms have already set up an international procurement office (IPO) in Taiwan to conduct OEM purchasing operations there. IBM, for example, established its Taiwan IPO as early as 1966 and the office is now manned by a staff of 60. Purchases have grown 20% to 30% annually in recent years, topping $278 million in 1987, virtually making IBM the biggest exporter that year. Big Blue now relies on 57 indigenous companies to fulfill its needs. Among these firms are such local luminaries as Tatung, Teco and Sampo. Some 2,100 workers are engaged in the related projects. Major purchase items are of a rather sophisticated nature, for example, plasma displays with 0.29-millimeter resolutions.

Unisys Corp. is another international firm whose IPO has been active. Purchases by the company's Taiwan IPO, which was set up four years ago, will reach $75 million this year, more than twice the 1987 figure of $31 million, according to L. S. Wu, the firm's manager. Included on its shopping list are high-performance displays, workstations, power supplies, eight-layer PCBs used in mainframes, cables, precision components for high-density disk drives, and parts for personal computers based on Intel Corp.'s 80386 microprocessors.

Also four years old, Hewlett-Packard Co.'s IPO is purchasing such items as transformers, coils, power supplies for minicomputers, die castings for disk drives, membrane switches, keyboards, PC boards, and even plastic molds, which can cost as much as several hundred thousand dollars per unit. Sken Chao, the firm's manager, refuses to reveal the figure for HP's total purchasing, but reports the amount grew 400% in 1987 and will double this year and next.

Taiwan's exports of information products



Source: Taiwan Information Industry Institute

NCR spends $30 million

NCR Corp.'s IPO, established a half-decade ago, doled out some $30 million in 1987 for such items as power supplies, keyboards, eight-layer PCBs and connectors. Honeywell Bull spent $5 million last year, mainly for terminals, monitors, keyboards and PWBs. Honeywell itself is buying passive components and die castings, among other items. "Name a leading international computer firm, and you can almost be certain to find its IPO in Taiwan," remarks Wu of Unisys. He estimates that the number of such IPOs now totals 30.

The major reason prompting international computer firms to shop in Taiwan is, of course, cost savings. "After taking transportation fees and tariffs into consideration, the purchasing cost here, on a free-on-board basis, is at least 20% lower than the cost in the U.S. Otherwise it's not worthwhile," says HP's Chao.

Engineering expertise

Another important lure is the island republic's engineering and technical expertise. Local firms are able to design and manufacture a product according to any specifications provided by foreign computer companies instead of having to rely on the latter's manufacturing blueprints entirely. "The competent engineering capability of local manufacturers enables foreign computer firms to shorten the leadtime from design to production by one-third. This is a crucial advantage in the highly competitive world market," asserts Chao.

The existence of sufficient engineering manpower in Taiwan has also greatly facilitated IPO operations. "In other countries, it's quite unlikely to find so many persons with engineering backgrounds to conduct IPO activities," notes Sheng Ko-kao, IPO manager for Honeywell Bull. At the firm's IPO, five of the eight staff members have engineering backgrounds. In IBM Taiwan's IPO office, 70% of the 60-employee staff are engineers.

Another important consideration is the small-scale operation of most local computer firms which — unlike their South Korean counterparts — have the flexibility to accept small orders. Furthermore, Taiwan boasts a well-established electronics infrastructure.

Consequently, many international firms such as IBM and Unisys have found that, behind Japan, Taiwan is now their second largest source of computer parts in Asia. The Taiwan IPOs tend to focus mainly on the purchase of components while the Japan IPOs generally concentrate on high-end finished products such as printers and disk drives. The South Korean IPOs usually end up buying low-end items such as monitors and terminals.

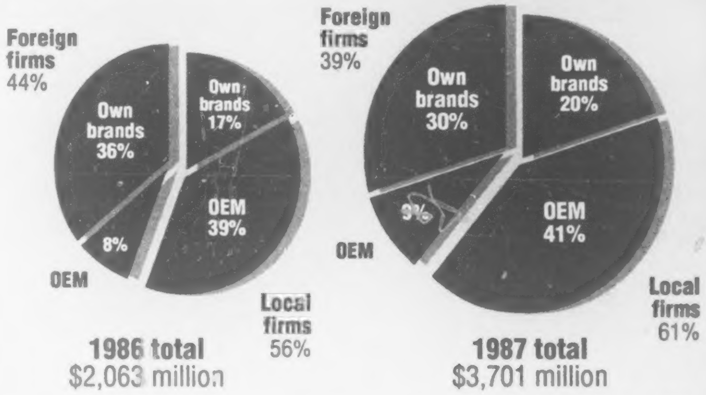
Serving as a bridge

Essentially, foreign companies use their IPOs as bridges between their factories and Taiwan's local suppliers, finding quality products for the former and helping the latter sell their technology and production capacities. IBM's IPO in Taiwan acts as the primary middleman between a Big Blue factory and a local manufacturer by negotiating prices, settling orders, providing technical support, and assuring the quality and punctual delivery of the purchased goods. "For every one purchasing agent in our IPO, we have 2.52 engineers to provide technical support to our local suppliers," says IBM Taiwan's Michael Huang. "For sophisticated products, we even introduce technology to local manufacturers."

Indeed, for the purpose of technology transfer, IBM has spent $2.2 million in the past three years to invite eight Big Blue engineers to Taiwan and to send three local engineers abroad annually. Furthermore, in 1987 alone, a total of 400 IBM purchasing agents visited Taiwan for business negotiations. "Everyday, you can see at least three to four foreign visitors at our office," says Huang.

Taiwan's information products export breakdown

Exports of information processing products by local and foreign-owned firms



Source: Taiwan Information Industry Institute

A consumer mentality

To assure the quality of the goods purchased, IBM Taiwan's IPO helps manufacturers eliminate possible defects through statistical monitoring of the various production processes, rather than resorting to checks upon the delivery of goods. However, quality is still the major obstacle hindering the further development of Taiwan's OEM sales, according to most IPO managers. "We are striving to lower the proportion of defective products to 0.5%, like that of Japan, but there is still some distance to go," notes Edward Lai, NCR Taiwan's IPO manager. Lai adds, "Many local manufacturers are still staying in the realm of consumer goods in their mentality and cannot live up to the high-precision requirement for industrial goods."

> **The major reason why U.S. computer firms shop in Taiwan is, of course, cost savings**

Some IPO managers also express concern that many local manufacturers, distracted by potentially lucrative speculation in Taiwan's overheated stock and real estate markets, are reluctant to engage in vigorous investment activities, a phenomenon which threatens the future development of the island republic's information industry.

Insufficiencies

IPO managers also complain about Taiwan's insufficiency of mechanical and materials engineering capabilities. In addition, IPO managers cite an absence of long-term business planning on the part of local suppliers, who sometimes jeopardize long-term partnerships for short-term windfalls.

IPO managers, in general, however, are harboring a rosy outlook for their purchasing operations in Taiwan. "We expect to continue maintaining high growth in our purchasing for at least the next two years and the value-added of our purchased products will be increasingly higher," says Wu of Unisys Taiwan. To further assure the supply from local manufacturers, NCR Taiwan has even decided to set up a PC assembly operation on the island and invest in some of its local suppliers. ☐

Software that links design to test: A step closer?

Board makers want ATE vendors to cut their test costs; vendors say users must take design initiatives. Board complexity is forcing a resolution

BY TONY GREENE

Joe Fuller knows it's going to cost a bundle before he even starts. As test engineering manager for Flextronix Inc., a Newark, California-based specialist in assembling and testing surface mount circuit boards, he figures on spending $15,000 to $34,000 to generate the test patterns and create the fixtures for a board test.

And that's just for an in-circuit test taking up to 12 weeks. Forget about functional testing: with engineering time clocking $2,000 a week, the idea never crosses Fuller's mind because the three to six months it takes to generate the relevant test patterns is just too long — and too costly.

High cost of test is a perennial problem for managers like Joe Fuller, particularly as board complexity rises and as surface-mount technology gains acceptance. And it's one that is beginning to reshape the automated test equipment (ATE) industry as newcomers emerge with low-cost gear and the big vendors answer with solutions of their own.

Fuller thinks he has the problem fingered: it's software, or lack of it. What's needed is software that is capable of taking information from computer-aided engineering design files and generating test patterns with it. "The hardware to take CAE data is there," says Fuller, "but the software is not. The in-circuit test equipment manufacturers need to develop a way to download CAE simulation into a tester. One of our biggest problems is trying to make test easier to generate, so we lower the cost of test."

For years, though, board customers and ATE vendors have used the "not my job" ploy to pass the design-through-test ball back and forth. ATE makers maintain that they've bent over backward to help make test simpler; customers say they've had little cooperation. That is having to change, though: as boards grow more complicated, top quality becomes mandatory and mistakes start to cost big money.

Not that the lack of a good interface between design and test is stopping people from buying the machines. According to a report by Mountain View, California-based Market Intelligence Research Co., the total worldwide market for PCB test equipment will be worth $706.9 million this year, and will continue to grow steadily to $1.13 billion by 1992. While there is talk of a slump in the near future for ATE, Stephen Balog, an analyst with investment brokerage Shearson Lehman Hutton Inc. of New York City, believes there will be some demand regardless of the economy, due to a need in the industry to retool.

Separating design and test means having to recreate the board for manufacturing, says Joe Lassiter, Teradyne's VP for Manufacturing Systems

The savings possible with a system that integrates design and test are not imaginary. A hypothetical example in a recent report by market research firm Electronic Trend Publications shows how this type of integration can turn into real money quickly on a board containing 150 semiconductor devices, 15 of them ASICs. For a multilayer board of this type, design and test engineering costs would typically average $66,000.

Immediate savings

If the design and test engineering systems are linked, an immediate savings of $10,000 can be realized by eliminating the duplication of new circuit models. Another $6,000 is saved by not having to reenter circuit topology and develop test vectors. The integration brings the nonrecurring engineering cost down 24% to $50,000. In a company that does 25 new boards like this each year, the annual savings could be $400,000. The savings also spill over into recurring cost by making it easier to test the board. Consequently, notes the report, the total return on investment on a CAE/ATE tie-in could exceed 1,000%.

Those kinds of returns are enough to galvanize even the most traditional test executives. Much as they hate to do it, they all have to test boards that these days are just too expensive to build and repair to risk their being dead on arrival at the customer. Just-in-time manufacturing is also pushing the need to test boards since customers want product that arrives ready to use.

So far, though, those managers in charge of test haven't gotten much satisfaction. Despite all the hype, workable links between design and test haven't arrived. "Tester and CAE workstations have to be able to talk better. We have to have an integration between the two disciplines [design and test]," insists Kenneth Neff, a market watcher at San Jose-based research firm Prime Data Inc.

The ATE vendors are still working on ways to provide those links. Three major strategies being pursued are:

- Standalone software solutions provided by the vendor that can be ported into the vendors' hardware solutions. Teradyne Inc. of Boston, one of the leaders in the board test market, is following this strategy with the creation of the Design and Test automation group, and with its purchase of Aida Corp. and Case Technologies Inc. Teradyne entered the CAE market with Lasar, software it has sold in conjunction with its test equipment for years. Teradyne sold about $120 million in board test equipment last year; and spent over $15 million on R&D, about half of that on software development.
- Test generation software that is part of the test system package. GenRad Inc. of Concord, Mass., has taken this approach with its Genesis software that includes system Hilo, a simulation toolkit that goes from design verification to automatic test generation. This software is one of the major features of GenRad's new GR2750 board tester. GenRad has also entered into strategic agreements with companies such as Diagonal Systems Ltd. of Zurich, Switzerland, to create a system that links design information from all major workstation companies to GenRad board test systems. GenRad spent $23 million on R&D last year, as much as 75% of it on software development.

Richard J. Faubert, VP for product development for GenRad: "Test and design should be happening in parallel"

- Designing open test systems that will be able to interface with whatever tools the customer is using. "The reality is that we have to live in a multitool environment," says Alex Beavers, vice president for field marketing and federal systems for Schlumberger Technologies of New York City. Hewlett-Packard Co. of Palo Alto, Calif., also follows this philosophy and has concentrated on test fixturing. "We believe, in terms of simulation, that we need to be able to integrate it into our own system. We have a product that goes out to the printed circuit layout system," says HP's general manager of manufacturing, John Scruggs.

It's up to the customer

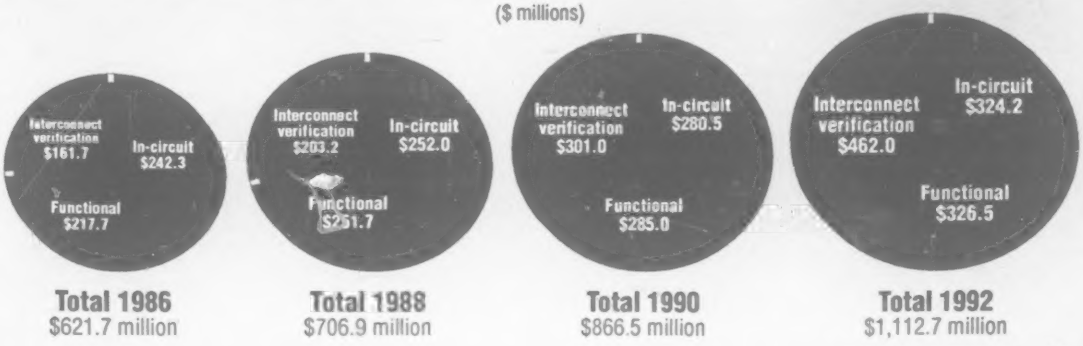
Implementation is up to the customer, though. "If people will design for test, the integration [of design and test] will happen naturally," says Teradyne's manufacturing systems division vice president Joseph B. Lassiter. "If you design things so that they can be tested, you can really integrate effectively. But as you separate them, you create a situation where you have to recreate the product to manufacture it," he says.

"A change in management philosophy toward test is necessary," contends Richard J. Faubert, vice president for product devlopment for GenRad. "Test and design should be happening in parallel." Market analyst Carolyn Rogers of Hambrecht & Quist Inc. agrees: "You don't just have to change the software, the philosophy of test has to change."

Despite what they say, test equipment makers are not alone in their quest to change the philosophy of test. Robert Russell, principal test engineer for Honeywell-Bull Inc.'s Brighton, Mass., facility says, "It doesn't make sense to wildly make a board you can't test. A test engineer will always look at a board at some stage of development and give the designer input. You need design and test working in parallel." Russell boasts that Honeywell-Bull's design

Worldwide PCB ATE market

($ millions)



Source: Market Intelligence Research Co.

and test engineers have been working together for 10 years.

The forces driving for a new philosophy in test are also encouraging other changes in the test industry. One of these is the birth of a new breed of tester — a combinational tester that handles both in-circuit and functional test. Teradyne, Hewlett-Packard and GenRad have all put new entries into the field in this area. GenRad's Faubert says, "The technology on the boards is forcing people toward a mix of functional and in-circuit test." Adds HP's Scruggs, "Our focus is very strongly in the area of combinational test. We want to meet the needs of customers using SMT and ASICs."

Built-in test

Another sea change is the push for built-in test techniques, where testability is designed into the board. "Without some kind of built-in test, people are not going to test their boards," says Prime's Neff. "In the next five years or so, it is going to become mandatory." Built-in test, such as boundary scan — a method that allows examination of just the "boundary," or inputs and outputs from a chip on a board to be tested — also relieves some of the test-generation nightmares caused by today's boards.

In addition, many small test equipment companies are coming on the scene to offer low-cost test solutions. One of these, Support Technologies Inc., of Portland, Ore., functionally tests boards by accessing the boards' microprocessors and running the boards at speed. Marconi Instruments Inc.'s Avionics Division uses Support Technologies Inc.'s 3000 Series machine, whose price tag of up to $80,000 looks paltry alongside the $1 million label that conventional large functional machines carry. Explains Frank Riccardi, Marconi's test engineering section head, "It didn't make sense for us to buy a big functional tester."

Built-in test relieves some of the test-generation nightmares caused by today's boards

Summation Inc. is another newcomer offering a low-cost solution to the large problem of functional test. With equipment prices checking in at $40,000 to $80,000, the little Kirkland, Wash., firm offers mixed signal functional test coverage. Both Summation and Support Technologies have concentrated heavily on software that makes test generation easier and faster, and both have implemented this software through innovative techniques for accessing boards.

While these companies — Support Technologies with sales of $6 million and Summation at $10 million — are dwarfed by the test giants, the business they are taking away could still become a thorn in the side of the Teradynes and GenRads. Notes one observer: "For each $25,000 machine they sell, they may take the place of a $500,000 GenRad machine." ☐

New names for old testers?

The jury is still out and the debate rages on over which is better — in-circuit or functional test. Since the earliest days of the board test business, the benefits, costs and problems created and solved by these machines have spawned fierce loyalties and bitter feuds. The question is: Who's winning the battle?

The answer is: both. "In-circuit is living and flourishing and will continue to flourish for the bulk of general commercial products," says Joseph Lassiter, vice president for manufacturing systems at Boston-based Teradyne Inc., "and functional test will be here forever for military boards and high-end commercial products." The figures back this up, with Teradyne's $120 million in board test equipment being split right down the middle between functional and in-circuit. Asked to pick one as the best, Lassiter says, "If you have time, functional is a better test."

At Concord, Mass., ATE vendor GenRad Inc., Richard J. Faubert, vice president for product development says, "In-circuit and functional is a bad partitioning." GenRad has begun defining its board testers as *process* or *performance* testers. This distinction is more a difference in price than method of test. *Process* testers cost less — at under $500,000 — than *performance* testers, which price out at over $500,000. "The technology on the boards is forcing people toward a mix of functional and in-circuit test," explains Faubert.

Combinational testers are not creating a new market

Kenneth Neff, an analyst for Prime Data Inc. of San Jose, agrees that the definitions are changing, and says what the consumer is looking for is a low-cost machine that does both in-circuit and functional test. This has given birth to a new contender — the combinational tester. The definition is not firm, and Neff says, "Combinational testers have been around for about four years, but this year we are going to start tracking them." Neff says that the market share they take will probably come from the share of pure functional testers. Combinational testers are not creating a new market, but they are competing with their parents for the same markets.

These testers are not only going to have to do more, they are going to have to do it for less. William B. Bean, president of low-end ATE vendor Marconi Instruments Inc., says, "In the U.S., the real action is going to be in low-cost test solutions. There is going to be a dramatic switch from mid-price to low-price systems." In answer to this need, Marconi has come out with a combinational tester that comes in between $45,000 and $65,000. ☐

EXECUTIVE VIEWPOINT

PRINTED CIRCUIT BOARDS

Wanted: U.S.-made printed wiring boards

In the U.S., the Japanese want local PWB sources. If U.S. firms don't shape up, Japanese PWB suppliers could invade the market

BY HAYAO NAKAHARA

Hayao Nakahara is managing director of Far Eastern operations for the PCK Technology Division of Kollmorgen Corp.

Many Japanese electronics firms engaged in manufacturing operations in the United States have basically been doing assembly work, or so-called "knockdown" manufacturing. However, the soaring value of the Japanese yen and mounting political pressure to resolve, or at least ease, the current trade imbalance are pressuring these companies to buy more local parts from U.S. sources. Many of the U.S. operations of Japanese companies are finding good components that are made in the United States and are cheaper than those from Japan. However, there are still many critical parts which cannot satisfy their requirements. Printed wiring boards (PWBs) are one such item. The United States is home to many excellent PWB manufacturers, but these are normally captive shops.

In the past few months, I've visited a dozen Japanese knockdown manufacturing facilities scattered throughout the United States. Their complaints are almost identical:

- Many independent PWB shops in the United States say they have the best quality around. Many boast of the number of board layers they can laminate. But their clean rooms are not always clean. Operators are often not wearing hats; their long hair hangs down. And yet these shops brag about their terrific quality control.
- The facilities that do quality work are already tied up with U.S. customers. Foreign-owned operations have no chance to be served.
- U.S. PWB shops are rather conservative in spite of their leading technology. When approached with designs involving 5-mil lines with 5-mil spaces and small via holes of 12- to 14-mils in diameter, many either shy away or quote very high prices and long delivery dates.
- Japanese electronics manufacturers use more boards with surface mount technology than their U.S. counterparts. Board quality consistency is essential for mass assembly of SMT boards. But, because of the limited quantities available from any one shop in the U.S., the Japanese must depend on several suppliers to satisfy their volume requirements. This makes it difficult to achieve satisfactory consistency of board quality. Common problems include board warp and twist, and misregistration of the solder mask, to name a few.

And the list goes on. The complaints may sound overly critical, but they are the same heard from American buyers roaming around the Far East in search of PWBs there.

The PWB industry today is a capital-intensive business, just as the semiconductor industry is. Many independent PWB shops in the United States are undercapitalized. The average independent U.S. shop is much smaller than its Japanese counterpart. There are over 1,000 PWB manufacturers in the United States and they produce about $5 billion worth of PWBs annually. By contrast, in Japan, there are 300 or so manufacturers producing almost the same amount. Because of such circumstances, Japanese systems houses manufacturing in the United States are asking their board suppliers in Japan to come here and erect local PWB manufacturing plants in order to supply quality boards in volume and at competitive prices.

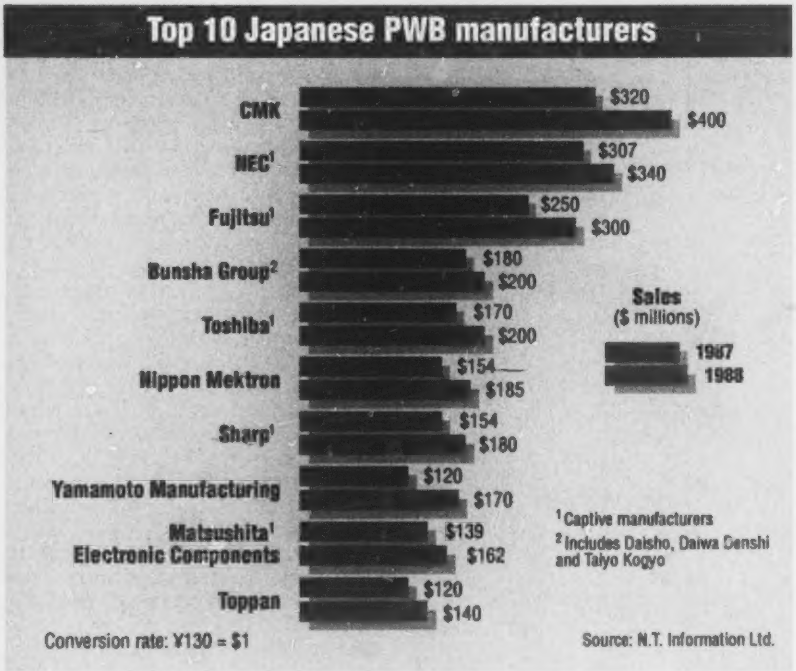
Another reason for the encouragement is the Japanese systems houses' unfamiliarity in dealing with U.S. board suppliers and American business practices. For example, the price for prototype boards in Japan is not much more than the price for mass production units, because the Japanese vendors hope that with an initial sale, they can then win mass production orders.

The Japanese are also used to working with shorter leadtimes. Even when business is booming, the longest leadtime in Japan is between four and five weeks, whereas in the U.S., it is normally 12 to 15 weeks under similar circumstances.

Furthermore, in the United States, it is customary for board manufacturers to be able to charge 30% to 50% more if their delivery times are shorter than the prevailing industry leadtimes. However, in Japan, this is not the case. In fact, if a PWB manufacturer in Japan insists on charging extra, the company leaves itself open to a harsh penalty fee if the delivery date is delayed. Yet, in the United States, PWB manufacturers just shrug their shoulders when their deliveries are tardy.

Not surprisingly, in the past few years, a number of Japanese independent PWB manufacturers have been investigating the possibility of building manufacturing plants in the United States under strong pressure from their customers operating here. Topri was the first Japanese company to build a U.S. PWB facility in the late 1970s, but it went belly up for various reasons. The lack of marketing skill in this marketplace was probably the No. 1 reason.

Hitachi Chemical Company Ltd. built a board manufacturing plant near Atlanta in 1985, but its customers are 100% U.S. companies. CMK purchased a property near the U.S.-Mexico border as a future plant site. NOK Corp. has been building a PWB plant in Silicon Valley, which is sup-



Top 10 Japanese PWB manufacturers

[1] Captive manufacturers

[2] Includes Daisho, Daiwa Denshi and Taiyo Kogyo

Conversion rate: ¥130 = $1

Source: N.T. Information Ltd.

posed to be operational in January 1989. Its PWB division is better known as Nippon Mektron. Former ally of the Rogers Corp. of Rogers, Conn., it produces about $170 million dollars worth of flexible PWBs, roughly 35% of Japan's total annual production of such boards.

Some Japanese PWB makers are also looking to buy existing facilities. Toppan Printing Co. recently entered into an agreement to purchase Industrial Circuits Inc. of San Diego.

But all these firms are big companies with financial clout. The PWB companies that are under fire to come to the U.S. to serve their Japanese customers operating here are medium- to large-sized independents. It is difficult for them to do so.

There are several reasons why. First, they are fiercely competing to hang onto their existing customers in Japan whose requirements for pricing, delivery and quality get tougher every year. And to satisfy the ever-increasing demands, they must keep investing — not necessarily in productive machinery, but also nonproductive equipment such as automated optical inspection systems, fancier electrical testers, waste treatment facilities, etc. It is called the "bicycle syndrome." If one stops pedaling, he falls. And the profits are very thin, not like in the good old days of the 1970s and early 1980s. The investment in Japan is so heavy for the medium- to large-sized independents that they haven't any capital left to set up a plant in the United States.

Second, unlike captive shops which normally belong to large conglomerates, independents cannot attract graduates from the famous Japanese universities that produce engineers possessing a fair command of the English language. Those graduates with foreign language capabilities seek jobs elsewhere. So, independents have no one in their organization qualified to spearhead a project in the United States.

Several independent Japanese PWB makers are forming partnerships in the U.S.

Third, even if they could go ahead with building a plant, they do not have the marketing expertise necessary to sell their products in the United States. And they just cannot afford to depend solely upon their Japanese customers. They must sell in the worldwide market to justify the risky investment, ranging from a minimum of $20 million to upward of $35 million, required to establish a U.S. plant.

So, what's happening is that several Japanese independent PWB manufacturers have established liaison offices in the United States, mainly on the West Coast, and have been trying to, through quoting activities, garner a feeling for prices and business practices in America. At the same time, they have been looking for U.S. partners that can deliver boards passing the specs demanded by those Japanese customers seeking quality parts. Various Japanese customer criteria — for solder mask misregistration; types of finish; thickness of gold plating, if desired; warp and twist; tolerance of error from datum to a certain key pad for surface mounting; etc. — are communicated between the Japanese board vendor and its prospective U.S. ally.

This approach is welcomed by both sides of the Pacific because the Japanese can serve their customers in a satisfactory manner and the U.S. "helper" can learn something from its Japanese partners, particularly in regard to automation.

There will be several such alliances springing up in the next few years. There may even be a few independents building their own shops here despite of the difficulties mentioned previously.

And it is only a matter of time before some so-called "captives" such as Fujitsu Ltd. and NEC Corp. begin building PWB manufacturing plants in the United States. Although considered captive, NEC, for example, sells more than 30% of its production — roughly 200,000 square feet of double-sided and four-layer boards — outside the company. In reality, many "captives" in Japan are not literally captive businesses. The board operations of Matsushita Electronic Components Company Ltd., Fujitsu, NEC, Toshiba Corp., and Oki Electric Industry Company Ltd., are all thought to be captives. However, they are all actively engaged in selling PWBs to outsiders, even to their parents' competitors. In fact, of Japan's top 20 largest PWB manufacturers, only Hitachi Ltd. does not sell its boards outside the company. ☐

to your RFP, i.e., estimated costs, leadtimes, quality levels, first delivery and other terms and conditions.

Review the responses to your RFP. The information supplied can provide the key ingredients for negotiating with and selecting the right contract manufacturer for your company.

Now you are ready to narrow your short list of candidates and select the best qualified contractor(s) — at least on paper. At this point, your team of purchasing agents, supplier quality and process engineers should be prepared to conduct initial site visits and engage in preliminary negotiations with the most promising potential contractors. You should now be set to review the results of the selection effort with your management team and obtain approval on your recommendations.

Final agreements on terms and conditions for production buys should be contingent on the contractor successfully passing your supplier qualification program. The supplier qualification and certification process described next is the best way to ensure that the contractor is indeed a capable producer and will be able to grow with you.

5. Qualify your contractor

Don't stop now. Unfortunately, the tendency after spending the time and effort to select a contractor is to congratulate yourself on a job well done and move on to other pressing business. For electronics manufacturers, selection should signal the beginning of qualifying and ultimately certifying a supplier.

Companies use a variety of methods and tests for declaring that a supplier (or contract manufacturer) is sufficiently worthy of being added to their "approved vendor list." Suppliers usually remain on such a list for a continuing period of time — unless, of course, something goes wrong. All too often, only the quality of the parts gets the buyer's attention. Little notice is given to the firm's business strengths and weaknesses. So, if problems crop up, they are usually surprises. It's too late when a company's ability to meet production schedules, cost targets or quality levels, has been adversely affected by lack of capital, capacity or process controls at a supplier.

As an alternative, we suggest an approach to the supplier qualification and certification process that separates evaluation of the part or assembly from that of the vendor's business. Treat these as separate issues and evaluate them independently.

To implement this process, you must first develop detailed criteria to evaluate both the ability to manufacture your components and the business capabilities of your contractor. Incorporate the part acceptance criteria and reliability testing into your engineering evaluation process. To review the business of your contractor, document and assign values to key criteria in a questionnaire format. Be sure your criteria adequately cover:

- financial condition and track record;
- competitive position, key customers and market share trends;
- engineering capabilities;
- technology assessment;
- manufacturing capacity and response time;
- and management.

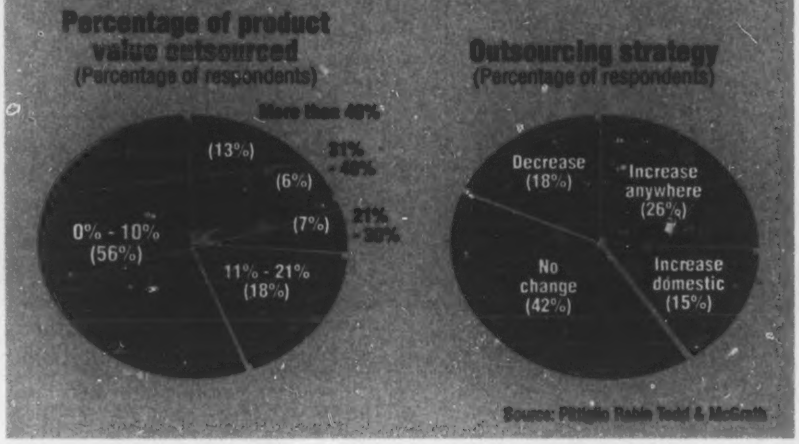
By assigning values to each question, the results of the survey can be expressed quantitatively. Qualification ratings, such as A, B, C and so on, can be established for scores in each category. To achieve an overall qualification rating, a supplier must receive at least that rating in each survey category. This is a critical step to successfully implementing this approach. The right individuals from your company must be involved, including:

- **senior management,** to meet with and assess the strengths and weaknesses of the supplier management team;
- **process, component and supplier quality engineers,** to evaluate and complete the manufacturing capacity, technology, process controls and engineering capabilities sections of the questionnaire;
- **marketing and finance divisions,** to assess the market position and financial position of your contractor;
- **and purchasing management/senior buyers,** to orchestrate the survey

Contract manufacturing is on the rise

Electronics manufacturers are looking to contractors to supply substantially more of their product needs, according to the American Electronics Association's 1988 Productivity Survey. Currently, the industry relies on contract manufacturers for only 19% of its product value, with 56% of the industry companies doing all production in house. The increase in contract manufacturing is also evidenced by the growth of major firms such as Flextronics Inc., SCI Systems Inc. and Solectron.

About 41% of the survey respondents indicated that they planned to place more work with contractors, while 18% will bring a portion of their work in house. The survey also detected a definite bias to using domestic rather than foreign contractors. □


Percentage of product value outsourced
(Percentage of respondents)

Outsourcing strategy
(Percentage of respondents)

Source: Pittiglio Rabin Todd & McGrath

ISDN is changing the face of telecommunications - slowly

Although widespread ISDN services won't be a global reality until sometime early in the 21st century, ISDN's here to stay

BY H. PARIS BURSTYN

Burstyn is director of telecommunications for Business Research Group, a newly formed market research arm of Cahners Publishing Co.

The first Integrated Services Digital Network (ISDN) commercial services are now available. By the year 2000, residential users and all size businesses will have access to ISDN services.

By the year 2010, I expect to see broad residential availability to a set of international standards, whose implementation provides an integrated point of access to a range of technologies and transmission paths for delivering simultaneous voice and data transmission.

But even though ISDN promises to dramatically alter the nature and provision of telecommunications services, ISDN's acceptance has been slow. This has been caused, in part, by the inability of carriers to explain adequately ISDN's vast potential.

Although digitalization (installation of digital switching and transmission systems) of the network was planned as part of routine network modernization, it requires carriers to make extensive capital investments. Digitalization provides the foundation for ISDN, but equipping the network for ISDN requires even greater capital expenditures. The investment is worthwhile, but carriers and their suppliers must better explain to subscribers the advantages some of the more sophisticated ISDN services can provide, and then price them reasonably to attract the customers they need to recoup that investment.

Three-tiered industry

The ISDN market comprises three tiers: subscribers, carriers and equipment suppliers. Sitting in the middle, the carriers play a crucial role. ISDN casts them as competitive, versus monopolistic, entities. Service providers must position any ISDN service so it can effectively replace customer premises equipment-based communications systems as well as solutions, based on combinations of separate network services. Carriers must carefully listen to subscribers and communicate their needs to their equipment suppliers, in order to deliver the software and hardware carriers need to service subscribers.

Digitalization allows carriers to provide subscribers with such ISDN-related service delivery architectures and systems as Signaling System 7 and database-oriented Intelligent Network. ISDN can integrate information from equal access software (or other central office software generics) and out-of-band signaling. This feature delivers the calling party's phone number and other data, so subscribers can combine that information with a database to provide customer profiles to the people who answer the phone. This service can improve the efficiency of telemarketing and customer service organizations. A similar, and in some ways competitive, feature is available on most digital PBXs, but ISDN can deliver signaling information from a distant central office so outside callers can also be recognized.

In other applications, ISDN can provide subscribers with the tools to reconfigure their public network services instantaneously to meet changing traffic patterns. Eventually, ISDN will automatically identify to the network the type of terminal being used to place a call, thus automatically routing workstations to data circuits; telephones to voice circuits; and video cameras to wideband facilities.

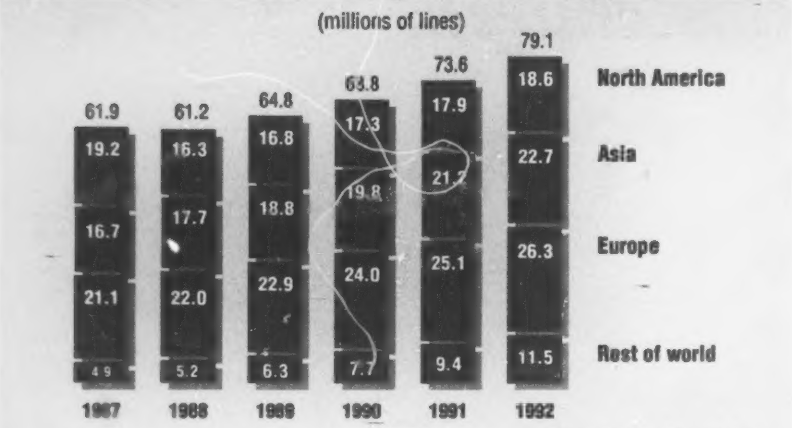
These new ISDN services differ from existing independent products and services. Although available systems could be pieced together to deliver something similar, doing so would take many man-hours coordinating a variety of vendors. Instead, ISDN offers the advantage of a single contact point for integrated services.

Effectively providing ISDN-based services rests on tying together extensive processing, software and database-oriented resources. The opportunities for vendors in each of these markets is extensive. To the subscriber, it makes no difference whether the applications processor it is using resides on its premises, in the network, or at some third-party facility. All that matters is that access to the applications is easy for the particular user and cost effective for the business.

Many opportunities exist for a range of joint marketing and joint venture arrangements among carriers, telecommunications equipment vendors, computer manufacturers and value-added network providers. Some carriers and their large customers are already working together to develop and justify ISDN applications. For example, AT&T, in conjunction with a number of large users and local exchange carriers, has inaugurated a program called TriVista. It brings a three-pronged approach to developing and evaluating potential ISDN applications.

Many companies have taken a conservative, wait-and-see approach to installing ISDN. Some large users, such as American Express and Tenneco, have been enticed to try ISDN. They are working with the carriers to develop ISDN-based applications and techniques for meeting business communications requirements. These uses will then trickle down to smaller companies and spread to—

Worldwide shipments of access lines



Source: Business Research Group

comparably sized companies.

Most importantly, subscriber needs will steer ISDN service evolution, and drive telecommunications equipment and service providers to develop network-based solutions to business problems. Secondarily, competition, regulation and technology determine the environment, guidelines and means by which telecommunications carriers and equipment suppliers deliver new ISDN products.

Changing global market

The list of companies — telecommunications carriers and equipment suppliers — responding to consumer demands includes some of the largest multinational corporations. But for most firms, ISDN market dynamics are different from those in which these firms are used to operating.

In European countries, domestic suppliers, such as Siemens in West Germany and Alcatel in France, have been virtually guaranteed the largest share of their post office and telecom equipment markets. But change in Europe is brewing; the European Community agreed to create a regional telecommunications market by 1992, to create more broad-based competition. Domestic market security is no longer assured.

In the United States, AT&T has only faced serious competition in the central office switch market, from Northern Telecom, for the last 10 years. But it recently enhanced its position in this market by agreeing to acquire GTE Corp.'s switching business, thus guaranteeing itself a large share of future purchases by GTE's operating telephone companies.

Japan's domestic suppliers, like Europe's, have enjoyed virtually exclusive access to their home market. But there is a possibility that some outside suppliers will land major switching contracts in that country.

With digitalization of the network progressing rapidly, I believe the way carriers price the integrated services provided over that digital network will be critical in this competitive, price-sensitive market. For example, one U.S. company using ISDN at no charge said it was so committed to ISDN it would stay with it despite what its local exchange carrier (LEC) eventually decided to charge. If the LEC's prices were too high, the subscriber would simply bypass it. Monopolistic government entities must also be aware of price sensitivity; traffic levels in Germany have been falling in recent years due, at least in part, to exceptionally high tariffs.

Despite the promise to alter services, ISDN's acceptance has been slow

Strategic role

In view of these developments, I believe ISDN will play a strategic role for carriers, equipment suppliers and subscribers.

- Carriers must use ISDN to win subscribers away from customer premises equipment-based (CPE-based) solutions. This will require designing useful services to attract subscribers and carefully gauging how much subscribers will pay for these services.
- Network equipment suppliers must continually enhance their equipment's ISDN capabilities to maintain and increase their market shares. They should, therefore, recognize which services carriers want to provide first and then prioritize their development efforts to meet those needs.
- Subscribers must evaluate ISDN as a potentially cost effective solution to a range of communications problems, and a source of more efficient communications resources unavailable until now. With a clearly defined market strategy, some subscribers could gain a competitive edge in their markets by employing ISDN-based services.

What's at stake for the suppliers are markets for both equipment and services that defy accurate description. Worldwide, carriers added nearly 62 million new access lines during 1987. Because digital switch costs-per-line vary widely, depending on vendor, the country, and the amount of government support provided, it is difficult to estimate an average price per line. Given that caveat, Business Research Group estimates the market for new switches in Asia, Europe and North America, where most of the world's ISDN-capable switch sales will take place, approached $49 billion in 1987. During 1988, the market remained virtually stable at about 61 million lines shipped and at $49.5 billion.

This situation of little growth originates from the fact that the U.S. market experienced a spurt during 1987 when over 19 million new lines of switching were installed. It settled back to slightly more than 16 million lines in 1988. That slowdown was offset by overall growth in the rest of the market. Increasing prices and inflation accounted for the growth in dollar volume.

BRG believes a very small portion of new lines shipped in 1987 were provisioned for ISDN. The first significant shipments of such lines took place in 1988, and by the end of the year we estimate that more than 12,000 ISDN lines will be in service in the United States. This number should increase extremely rapidly through 1991, when more than 10 million new lines will be shipped in North America. By then, the approximately 11 million total ISDN access lines installed will account for less than 5% of the total number of access lines in the region.

Europe should experience a similar shipment rate with about a year's lag time. That is, Europe should see about 55% of its new line shipments provisioned for ISDN in 1992.

Although the central office switch market is the most glamorous of the telecommunications equipment markets because it garners so much attention in the press, relative to the total equipment market, it accounts for a small portion of the world's telecommunications equipment market. Digital cross connect systems, subscriber loop systems, transmission gear, termination equipment and many other components add tremendous value to the market's potential. Equipment suppliers competed for nearly $99 billion of spending by the world's telecommunications carriers in 1987 and over $101 billion in 1988. And the market continues to grow. The signaling system component of ISDN network provides an excellent example of one source of market growth. Carriers that did not use interoffice signaling before must now install it, and those that used interoffice signaling in their toll networks must now extend it to local exchanges.

From the carrier's standpoint, the added revenue created by ISDN can play a critical role in helping pay for increasingly expensive network upgrades. The services go a long way toward high margin revenue streams. ISDN-derived revenue, which barely exists today, shows a potentially large new source of revenue and profit for carriers. Through 1990, as more ISDN installations come on-line and an inventory of applications is developed, worldwide ISDN service revenue could amount to $25 billion.

ISDN technology alone won't generate these new revenue streams. Subscribers will also require substantial education about ISDN and its applications. But most importantly, to generate this additional revenue, telephone operating companies and their suppliers, must guarantee the public network's ability to respond to subscriber demands for competitive pricing, service control, flexibility and reliability. Digitalization of the public network virtually guarantees that carriers can deliver customer-controlled, flexible and reliable ISDN-based services in areas where the regulatory environment allows such services. But it remains up to the carriers to employ this technology to deliver services that will successfully use network capabilities; generate adequate traffic and revenue to recover investments; and produce profit while meeting the needs of its customers. ☐

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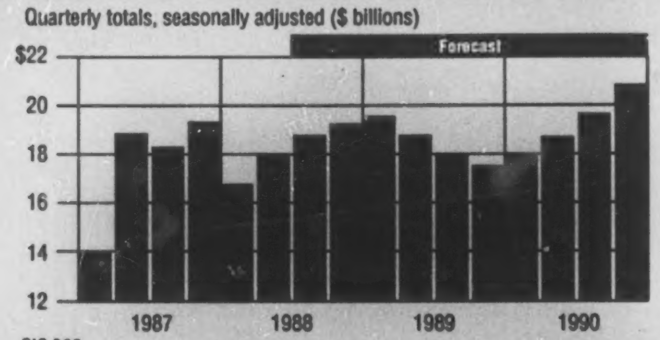
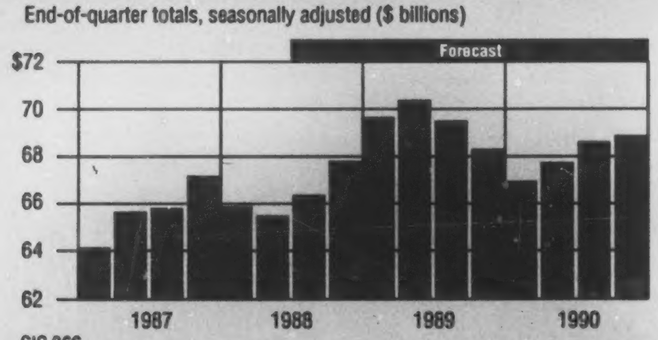
Communication equipment — New orders



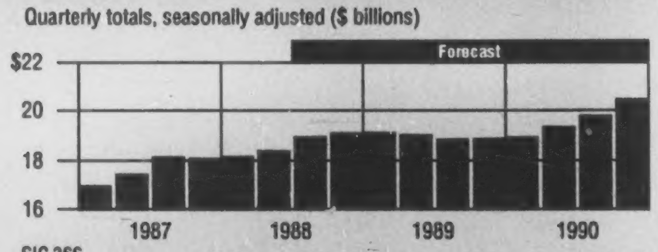
SIC 366 Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Communication equipment — Unfilled orders



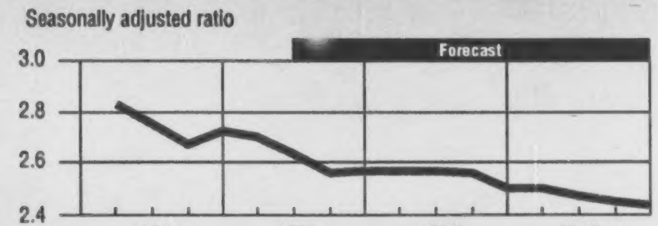
SIC 366 Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Communication equipment — Shipments



SIC 366 Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Communication equipment — Inventory-to-shipments



SIC 366 Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Communication equipment gains

The U.S. Census Bureau recently revised historical shipments, new orders, unfilled orders and inventory data back to 1982. The changes reduced the values of orders, shipments and backlogs for communication equipment for 1987 by about 5%, while inventory reflected little adjustment.

From July to August of this year, new orders for communication equipment took a nose dive, coming in at $5.8 billion, a decrease of 6.7%. Weak orders for radar, sonar, navigation equipment and other defense-related communication equipment were responsible for the decline, as new orders for nondefense communication equipment gathered strength in August.

Shipments trailed off 2.9% from month to month. Surprisingly, the big loser in this case was the commercial sector, while shipments of defense communication equipment remained stable. The decline brought the August total to $6.1 billion, just 1.7% ahead of the year-ago month. Although shipments will fluctuate on a monthly basis, don't expect annual growth to get above 6% this year. The commercial sector is expected to do slightly better than the overall. Factory shipments of nondefense communication equipment are expected to end 1988 about 7% to 8% higher than last year.

Foreign shipments, domestic investment up

Increased foreign sales are one reason for the renewed vigor. Through the first half of this year, U.S. exports of communication equipment (largely commercial) totaled $3.1 billion, a surge of about 31% above last year.

At the same time, growth in imports of communication equipment has slowed. From 42% annual growth in 1984, increases dwindled to less than 1% in 1987. Through the first six months of 1988, imports advanced about 4%. However, in dollar size, imports still dominate the market. Back in 1981, imports were about 2.2 times the size of exports. By 1987, the value of imports skyrocketed to 4.2 times the export value.

In 1988's second quarter, businesses purchased $43.7 billion worth of communication equipment. This represents increases of 10% from the year-ago quarter and 2.5% from the prior quarter.

But increases in equipment investment are slowing and the gain from exports won't be as great next year. All this will tell in the growth rates for orders and factory shipments of communication equipment.

MADELINE FRANCHI

Computer market is in good shape

The U.S. Census Bureau once again completed its annual revisions to shipments, orders, backlogs and inventory data. Changes to the 1987 data were significant. Orders and shipments for computers and office machinery were raised between 6% and 7%, while unfilled orders were cut from $18.7 billion to $14 billion at year-end.

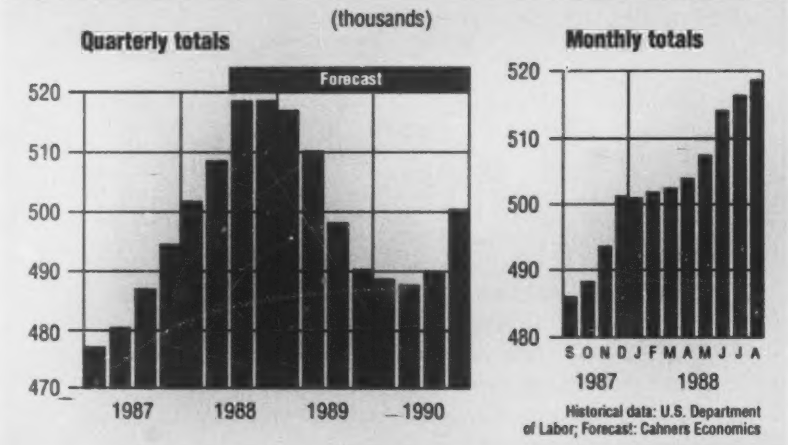
August was a good month for computer and office equipment makers. New orders swelled 5.6% from July up to almost $6.2 billion. Shipments advanced strongly, too, growing 2.1% from July to stand at $5.9 billion, or 15% above August of a year ago.

This strong showing keeps our forecast of 12% annual shipments growth in 1988 right on track. But remember, these series are measured in dollars, not units. So, some of this growth may be due to the sudden burst in computer prices as manufacturers finally passed on their increased costs for chips. Nevertheless, the current increases are good news and help mitigate fears that purchases of PCs were slowing down.

Another indicator of a robust market, employment, also increased. Total employment in the computer and office equipment industry edged up half a percent from July to August, or about 29,000 persons more than last August. Employment of production workers climbed almost 1% in the middle of the summer.

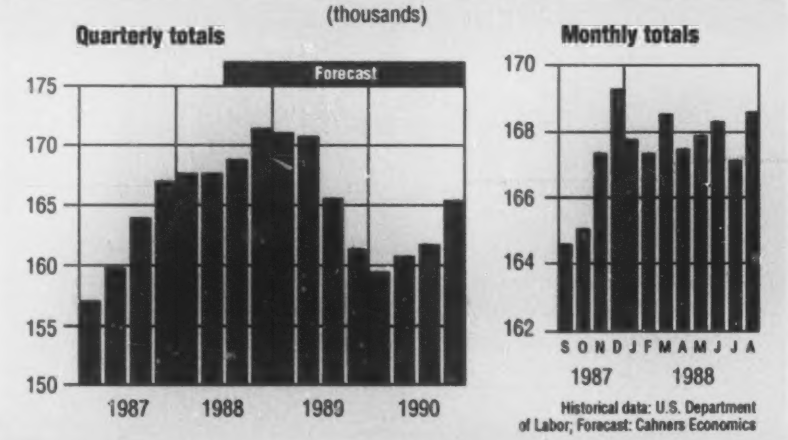
MADELINE FRANCHI

Computers and office machinery — Total employment



Historical data: U.S. Department of Labor; Forecast: Cahners Economics

Computers and office machinery — Production workers



Historical data: U.S. Department of Labor; Forecast: Cahners Economics

Computer market database

	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, Aug.)	317.6	315.9	+0.54%	282.1	+12.58%	318.3	+0.22%
Shipments (SA, $ millions, Aug.)	$5,899	$5,779	+2.08%	$5,123	+15.15%	$5,728	-2.90%
New orders (SA, $ millions, Aug.)	$6,180	$5,853	+5.59%	$5,066	+21.99%	$5,577	-9.76%
Unfilled orders (SA, $ millions, Aug.)	$14,175	$13,894	+2.02%	$14,221	-0.32%	$12,908	-8.94%
Inventory-to-shipment ratio (SA, Aug.)	1.96	1.99	—	2.03	—	1.95	—
All employees (thousands, Aug.)	518.6	516.1	+0.48%	489.6	+5.92%	498.1	-3.95%
Production workers (thousands, Aug.)	168.6	167.1	+0.90%	165.7	+1.75%	165.7	-1.71%
Exports ($ millions, Aug.)	$1,836	$1,787	-7.64%	$1,482	+25.7%	$1,820	+1.87%
Imports ($ millions, Aug.)	$1,959	$1,828	-10.21%	$1,589	+14.20%	$2,071	+13.33%

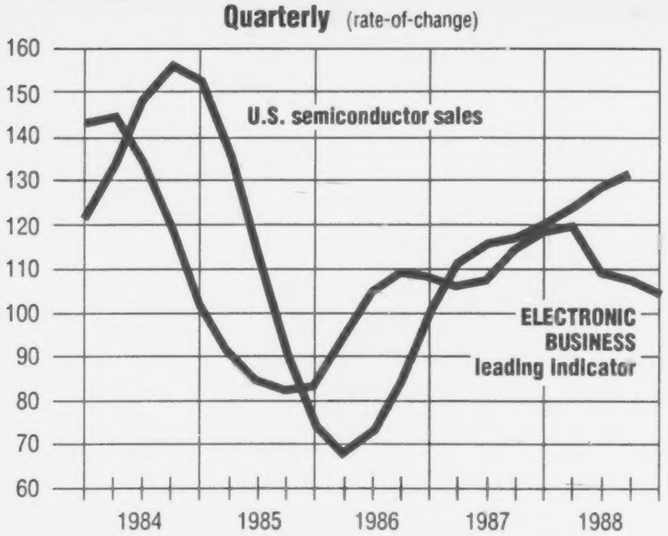
SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

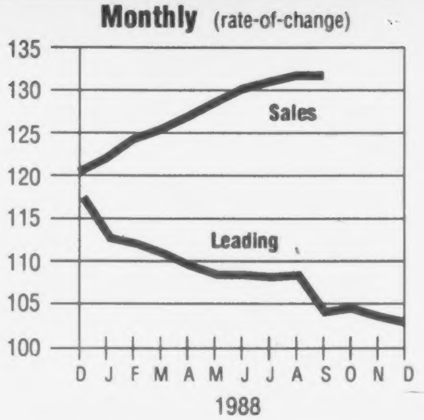
BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368



This past August, for the fourth month in a row, the ELECTRONIC BUSINESS leading indicator barely moved from the 108.5 level. That's an unusual pattern of stability for this business cycle which suggests 1989 will be a flat year for semiconductors and electronic equipment growth.

Source: Cahners Economics

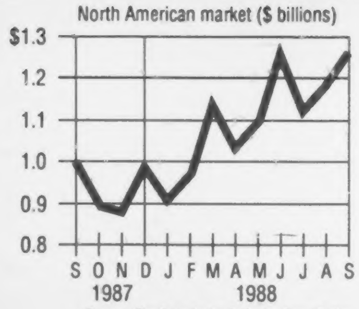
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1987 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Aug.)	108.7	103.5	113.6	111.1
U.S. semiconductor bookings ($ millions, 3-month average, Sept.)	$1,154	$1,209	$967	$951
Weekly hours of semiconductor production workers (monthly average, Aug.)	40.1	40.0	40.4	40.6
Electronic components leadtime index (1977 = 100, Oct.)	109.4	114.2	110.5	100.7
S&P's semiconductor stock price index (1970 =10, monthly average, Sept.)	51.0	54.1	82.1	65.5
Change in electronic components inventories ($ millions, SA, Aug.)	+$119	+$152	+$84	+$41
Contract and orders for plant and equipment ($ billions, SA, Aug.)	$43.1	$40.6	$34.9	$34.5

SA = seasonally adjusted, all other data is not seasonally adjusted

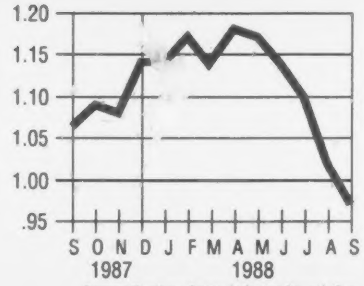
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



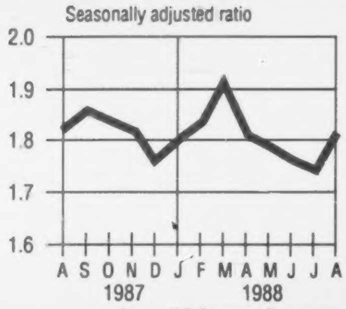
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department

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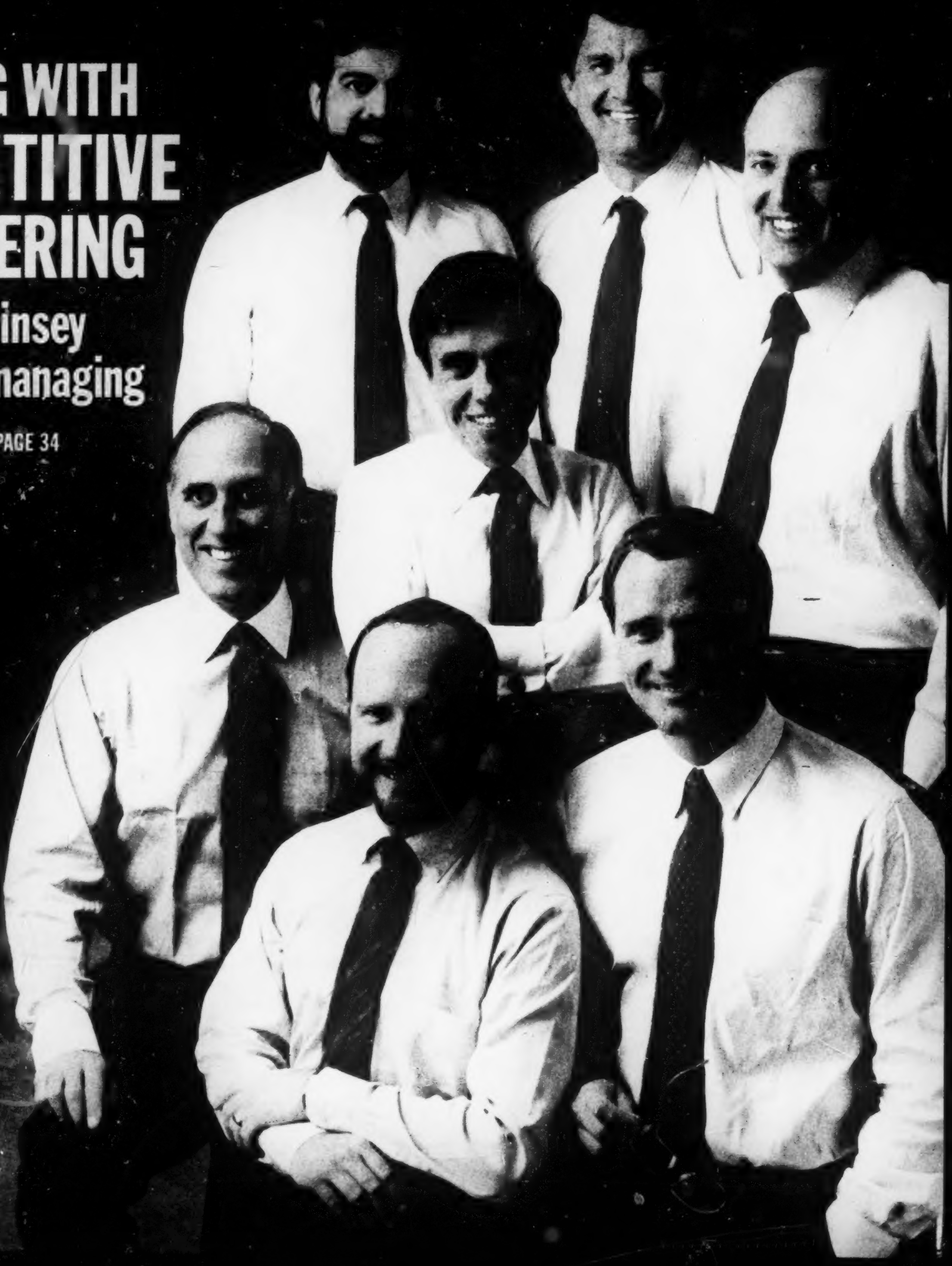
Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE JANUARY 9, 1989

WINNING WITH COMPETITIVE ENGINEERING

A new McKinsey series on managing engineers PAGE 34



McKinsey & Co.
Electronics practice

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

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JANUARY 9, 1989

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34 How to win with competitive engineering

Of all the functions that are performed by managers in the electronics industry, engineering may be the most vital and least understood. It lies at the very heart of the creative impetus that has made electronics the premier industry in the world. At the same time, engineering is frequently cited as the Achilles' heel of the industry. This first part in a new series by McKinsey & Co. will explain how engineering managers and corporate executives can harness engineering to give their company the competitive edge.

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Consumer electronics are Japan's key to the lucrative airplane cabin. Next flight, the plan is to put LCDs into the cockpit.

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While increased product complexity goes along with innovation, it also adds cost. How do you strike a balance?

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Cover photo: Christopher Springmann

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PAGE 54 Advent's Patrick Sansonetti: Venture capitalists push their portfolio companies overseas

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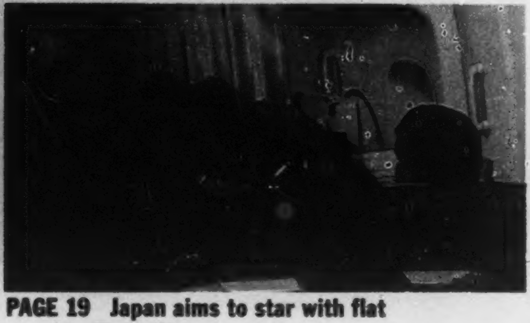

PAGE 19 Japan aims to star with flat panel in-flight flicks

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Expect scant sales growth in switches, and an actual dive in capacitor business. Relays should hold up, as will connectors.

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Welcome back, McKinsey

McKinsey & Co.'s Electronics Practice consulting team

Back in the early 1980s, just as the U.S. electronics industry was gathering real momentum, ELECTRONIC BUSINESS ran a series entitled "Keeping the Competitive Advantage," authored by consultancy McKinsey & Co. The highly acclaimed articles provided insight into a myriad of ways to improve business, from cutting product development time to managing joint ventures.

We're pleased to welcome McKinsey back. In this issue, they return with the first article in a series on management of engineering resources. The theme is "Winning with Competitive Engineering," and it's a theme you'll hear consistently as the series unrolls throughout 1989.

McKinsey's earlier advice was timely; the new series is no less appropriate. U.S. electronics firms may be leaner, meaner and more astute than ever before, but the challenges they face are tougher still.

We're supporting the series with two special ELECTRONIC BUSINESS seminars this month: one on Jan. 11 in San Jose, the other is on Jan. 18 in Boston. On both coasts, we're inviting our senior-management readers to meet the McKinsey authors to learn first-hand about the new strategic directions in engineering.

What's ahead in '89

For this issue, the editors at ELECTRONIC BUSINESS linked up with the economists upstairs in Cahners Economics to produce penetrating and original forecasts for each industry sector in the year ahead.

Our "Outlook 1989" section is no mere regurgitation of old data from the usual forecasters. It's based on detailed scrutiny of the economic tea leaves by Cahners' underrated analysts: James Haughey, Elizabeth Baatz and Madeline Franchi. Their findings, and our editors' presentations, should form crucial components of every manager's short-term planning.

Kilts and Kisses

We're also proud of this issue because it debuts a new section that we're calling "Management Styles." If the executive profiles it runs recall a certain page in *Time* magazine, that's no accident: people love reading about other people.

There's a distinct difference, though: recognizing that our senior-management readers have business to attend to, the new page connects the executive's personality firmly to the way he or she does business. Kilt swirling, kisses flying, LSI Logic president George Wells is our first candidate as senior editor Valerie Rice captures the essence of "Management Styles."

JOHN KERR, editor

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BPA ABP

Japan aims to star with flat panel in-flight flicks

Consumer electronics are Japan's key to the lucrative airplane cabin. Next flight, the plan is to put LCDs into the cockpit too

Japanese electronics are starting to show up in the booming market for commercial aircraft. But don't credit Japan's highly touted targeting of the aerospace industry yet. Credit Japanese consumer electronics technology.

Japan already runs a sizable aircraft industry: annualizing figures from the Japan Society of Aerospace Companies, 1988 revenue approaches $4 billion, with over $500 million of that in aviation instruments and communications equipment. And the nation's Ministry of International Trade and Industry (MITI) this year is plowing $148 million into aerospace research, a 42% gain on fiscal 1987.

But that's not what's behind Japan's push into in-flight entertainment. It's the nation's consumer-electronics producers that expect to be a big force in passenger entertainment systems that use flat panel liquid-crystal displays to screen movies in the backs of the seats. They are also targeting the cockpit, where new collision-avoidance systems may provide big revenue for flat panel displays.

Although not the sort of thing one usually thinks of as "avionics," these flat panel seat-back TV systems are one of the biggest potential growth areas for electronics on aircraft. At roughly $2,000 a seat to install the system on some 1.3 million seats on 6,000 commercial aircraft, there's a potential $2 billion to $3 billion market in the U.S. alone. The systems may start to show up on commercial flights as early as this year.

It's not a Japanese company that's ahead so far, though. It's Airvision of Valencia, Calif., a joint venture of N.V. Philips GL and Warner Communications Inc. "We're planning on installation [this] year," says Albert Ruimschotel, Airvision's senior vice president for marketing. "We're the only ones flying yet."

Northwest Airlines recently concluded a five-month test of the Airvision system on a 747 flying between Detroit and Tokyo. British Airways and Australia's Qantas Airways are currently testing the system, which uses off-the-shelf 3-inch LCDs from Philips.

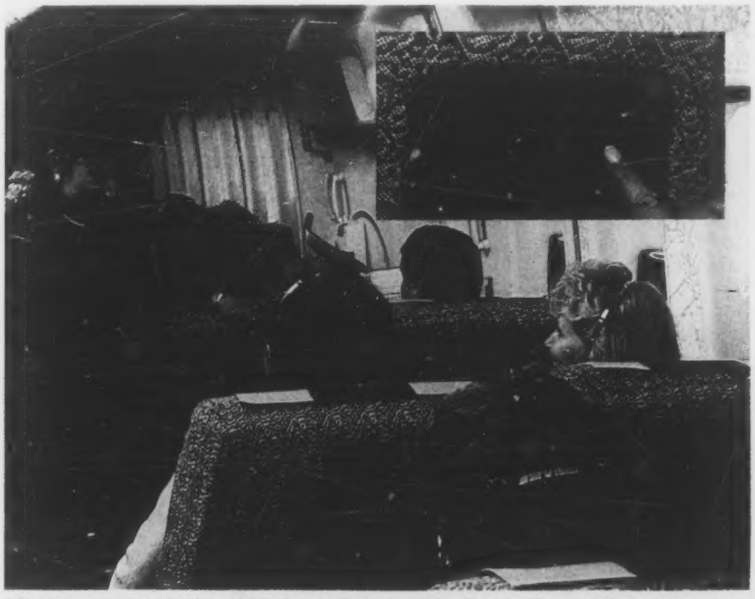
A Northwest spokesperson says the airline is encouraged by the enthusiastic passenger response, but is still evaluating the economics of the system. More than 70% of the passengers on the test plane watched the in-flight movies and television programs four hours or more on the 13-hour flight, felt the rental was a good value at even $8, and said they would choose to fly next time on an airline that offered the system.

Japanese consumer electronics giant Matsushita Electric Industrial Co. also plans to be a big player in the seat-back video market. The company says Japan Air Lines will install its system in its new 747-400 aircraft when it takes delivery from The Boeing Co. of Seattle. Matsushita is already a major supplier of entertainment systems for commercial aircraft, claiming up to 50% of the roughly $75 million audio market, largely from supplying its systems to Boeing. And it has a U.S. marketing structure ready to go: its 30 sales reps at Matsushita Avionics Systems in Bothell, Wash., already have established relationships with major U.S. airline customers from the audio business.

Matsushita is designing a system specifically for aircraft, which will be lighter and more rugged than existing systems put together from off-the-shelf components, and which will use a 5-inch LCD screen in the seat arm. The company is supplying its regular industrial video hardware on an OEM basis for several of its competitors' seat-back video systems as well.

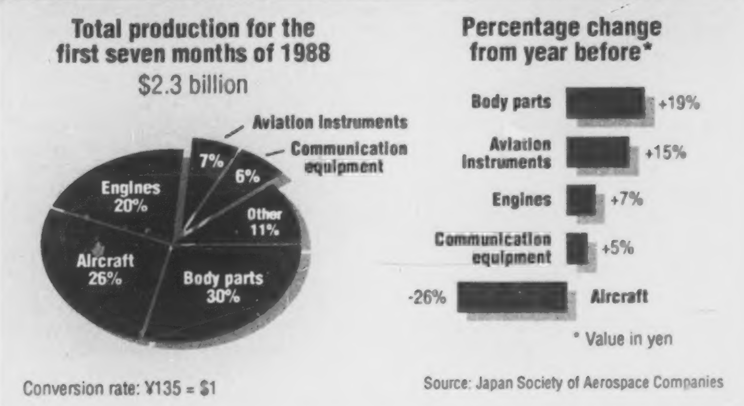
Virgin Atlantic Airlines is also reportedly talking to several Japanese vendors about installing 5-inch video systems on the London-Tokyo flights it initiates this spring.

Outside of entertainment systems, the Japanese presence in the U.S. avionics market has been minimal. Limited figures from the U.S. Commerce Department put Japanese imports of electronic measuring instruments, auto control instruments and naviga-



"Fasten your seat belts, and put your flat panel displays in the upright position." U.S. vendor Airvision made the displays for this "flight test"

Japan's aviation instruments business soars


Total production for the first seven months of 1988

$2.3 billion

Percentage change from year before*

* Value in yen

Conversion rate: ¥135 = $1

Source: Japan Society of Aerospace Companies

Electronics is a fast-growing sector of Japan's already large aerospace business

tional instruments for aircraft at under $8 million in 1987, although that is nearly double 1985 levels. Major system suppliers report no Japanese competition for their products, and little use of Japanese components.

Cockpit displays

Soon, though, significant numbers of Japanese flat-panel displays may start showing up in cockpits too. Mitsubishi Electric Corp. already supplies dedicated very high resolution CRTs for cockpit displays in some Boeing planes. And Japanese suppliers are involved in the development of the coming flat panel instrument displays.

"The Japanese have made large commitments to flat panel consumer television and, more important, 8- by 10-inch video data terminals, and we're counting on that kind of volume to reduce costs," says Phil Fenner, manager of displays and sensors for Boeing.

Boeing started work with the Japanese on a very high resolution, multipurpose, large-screen flat panel cockpit display for the 7J7, a new propjet that was to be developed with Japanese partners. Although the 7J7 program was shelved indefinitely for want of market interest, the display program was not. "It's moving forward just about as it was under the 7J7," says Fenner. The display is now targeted at derivative airplanes for the early 1990s. Boeing is working with three of its usual systems suppliers which will package and assemble the display, while Japanese companies focus on the key active matrix liquid crystal units. Involved in this and other Boeing flat panel programs are Seiko Epson, Hosiden Electronics Co. Ltd., and Stanley Electric Co. Ltd. "We're trying to get Sharp interested too," notes Fenner. "They have very good technology."

Coming even sooner are smaller, simpler flat panel displays to replace existing dedicated readouts. Boeing has a joint development program for these as well. Rockwell International Corp. bills the monochrome display for its Rockwell Collins data link system as the industry's first commercial flat panel active matrix cockpit LCD.

Mitsubishi already supplies CRTs for cockpit displays in some Boeing planes

But the first big market for flat panel cockpit displays is likely to be in collision avoidance systems. These new $100,000-plus systems are required by law by the end of 1991 on all of the 6,000 or so aircraft with more than 30 seats that fly in the U.S. Systems suppliers Rockwell and Allied-Signal Inc.'s Bendix/King Air Transport Avionics Division are both offering airlines a flat panel display option, combining the traffic alert information with the vertical airspeed indicator in a 3-inch flat panel display that would not require unusually high resolution. Japanese LCD makers are prime contenders to supply the glass for these displays.

In the less flashy business of avionic flow meters, switches and power supplies, the Japanese are selling products too. "We lost business on the F-15 fighter," notes Robert Brown, vice president of technology and central operations at Eldec Corp., a Lynnwood, Wash., maker of airborne power supplies. "And for the 7J7, Japanese companies were making a strong approach in things we had supplied."

Old-boy network

Despite these successes, it's not easy for the Japanese to break into the old-boy network to sell avionics systems outside of Japan. The airlines each specify the electronics on the planes they buy, and both airlines and air frame makers are used to dealing with a small fraternity of well known vendors. "We deal with vendors who're familiar to us," notes Frank Rasmussen, Boeing's chief engineer for flight management. "Electronics on aircraft tend to be custom — indeed more so than we'd like. There's lots of customer interface in electronics."

One way into the fraternity may be by financing development of the next generation of U.S. aircraft. The Japanese stand ready to chip in on the development of new planes whenever the market is ready for them. Although Boeing shelved the 7J7, the Japanese government didn't stop funding for the project: it continues at about $30 million a year, and roughly 40 Japanese researchers continue to work at Boeing.

Reports from Japan say the Japanese are talking with Boeing about participating in the development of a stretched version of the 767. Mitsui & Co. plans equity participation in McDonnell Douglas Corp.'s new propjet, if there's enough customer interest to start the project. "The target is the same as Boeing," says M. Sugaya, Mitsui's general manager of industrial machinery in Los Angeles. That goal, he says, is "more opportunities for Japanese vendors."

PAULA DOE

Board makers see reward in Motorola's RISC chip

Although late to the race, Motorola's 88000 processor is proving popular with board vendors, thanks to the 68000's reputation

Like a surfer intent on riding the biggest wave, independent add-in board makers are hoping to catch big profits on the RISC technology swell. Just which supplier of the speedy RISC architecture will provide that big wave remains to be seen, but for the moment Motorola Inc.'s 88000 microprocessor family — a latecomer to the RISC market — is forming the basis of at least 10 board makers' efforts.

Backing a particular RISC chip is a high-stakes call; RISC-based boards will likely become a substantial peripherals business. In VME bus boards alone, 25%, or $275 million worth, will be RISC-based by 1992, says the VMEbus International Trade Association (VITA). VITA's figures for the total world board market come to $1.9 billion this year, rising to $2.3 billion in 1990; if a quarter of all boards feature reduced instruction set architectures by 1992, the opportunities could be huge.

Many other RISC chips were up and running before Motorola unveiled its offering last spring: Intergraph Corp.'s Clipper; the Sparc design licensed by Sun Microsystems Inc. to IC makers such as Cypress Semiconductor Corp., LSI Logic Corp. and Fujitsu Microelectronics Inc.; and the architecture developed by MIPS Computer Systems Inc. The RISC roundup also includes the 29000 microprocessor from Advanced Micro Devices Inc.

But the 10 or so independent board builders betting on Motorola are doing so chiefly on the strength of the chip maker's reputation for meeting customer demands and producing quality microprocessors. Says Robert Gilks, CEO of Tadpole Technology Inc.: "We have worked with them before and have a very high regard for the Motorola product." (Tadpole hasn't ruled out using other RISC vendors.)

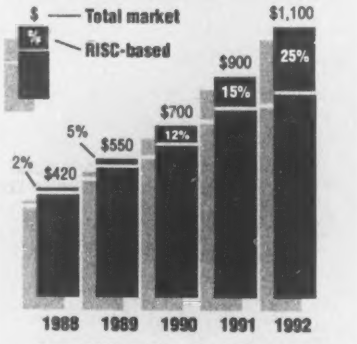
Others claim that the 88000 is simply a better, broader-based architecture. Enthusiasts boast that the 88000 stands out because of its two cache memory support units and multiprocessing, built-in fault tolerant capabilities and the integration of floating-point and integer functions on the CPU chip.

Tadpole spent close to $2 million of its $8 million revenue on R&D to harness RISC. Other board makers that have announced an 88000-based product include Integrated Micro Products Ltd. (IMP); Tektronix Inc.; Northern Telecom Inc.; and Force Computers Inc. IMP, with estimated 1987 sales of $10 million and over $1.5 million plowed into R&D on RISC boards, claims it was one of the first to market 88000 boards.

Besides the recent boom in RISC workstations, the board vendors are responding to growing applications in imaging, high-end simulation, embedded communications and office automation. RISC, observers say, will be implemented into any highly repetitive application allowing users to increase current computing power up to 30 times. "The challenge for the board industry is to be innovative to do what CISC can't," according to Marty Weisberg, Force Computer's executive vice president.

VMEbus board market

RISC-based boards' share of total market ($ millions)



Source: VMEbus International Trade Association

One big user could electrify the RISC board market: Apple Computer Inc. Although Apple remains tight-lipped, there is word that the PC giant, whose Macintoshes already use Motorola's 68000 processors, is eyeing the 88000. However, if Apple does introduce a RISC-based system, many companies will be interested in making add-in boards for them, according to Andrew Allison, editor of *RISC Management*, an industry newsletter.

Since last April, Tektronix has been marketing a systems development board for the Macintosh II designed around the 88000. Depite no volume silicon deliveries, Tek says sales of the board have been good. Depending on the amount of memory desired, Mac II users can expect to pay from $11,000 to $15,000 for the board. (Motorola indicates that add-in RISC boards will typically sell for $5,000 to $10,000.)

Ultimately, Motorola's market timing may have cost it business. "Where's the beef? Where's the silicon?" complains one board maker that has used Motorola's technology in alpha-site trials and is now waiting to employ the 88000 in volume. Several board manufacturers using other architectures say they did so because of availability. "We realized that we had to go to RISC architecture three years ago and the only architectures on the market then were Clipper and MIPS," says Forest Baskett, vice president for R&D for Silicon Graphics Computer Systems, which uses the MIPS version to enhance its graphics boards.

Volume shipments are on the way in early 1989, says Motorola; total shipments of the 88000 family should reach 50,000 by the end of this year, with ramped up production in 1990 and beyond. Motorola believes its timing isn't so bad. With software compatibility a key downside to implementing RISC technology, the company claims the 88000 will have standardized software in existence before volume 88000 is available — something observers say has never been done before. Already the 88open Consortium Ltd. has unveiled a Binary Compatibility Standard (BCS) that hardware and software vendors will be using to build 88000 products.

JOHN McCREADIE

Replacing the weakling of the workstation world

IBM's RT has been big on family connections, short on performance and pathetic on sales. The Armonk giant has to change that this year

BY RICK WHITING

Underpowered and overpriced, IBM's RT workstation is often mentioned in the same breath with such other notable Big Blue Edsels as the PC*jr* microcomputer.

But unlike the stillborn PC*jr*, IBM has stuck with the RT and this year, more powerful versions of the workstation are on the horizon. With IBM's marketing muscle and huge customer base, analysts say a competitive RT has the potential to remake the workstation landscape.

"They will come out with a blockbuster that will set the standard for this industry, just as they set the standard for the PC industry," predicts Charles Foundyller, president of the Daratech Inc. CAD/CAM market research firm in Cambridge, Mass.

The difference, however, is that while IBM virtually created the PC market, the workstation business has been booming for several years without IBM's help, leaving the company with some catching up to do.

The RT made its debut in January 1986, and even IBM executives acknowledge that the early versions were computational lightweights. "We made an error in that it was not as powerful as it needed to be and did not have the suite of applications it needed," says Linda Fabel, director of AIX and technical workstations.

Since its unveiling, the RT has been enhanced about once a year. From the first workstation's performance of about 1.5 million instructions per second, the system's power has increased steadily to its current top-of-the-line performance of about 5.5 MIPS. Pricing for the workstation line now ranges from about $23,000 for a low-end system to about $32,000 at the high end.

IBM's director of AIX and technical workstations, Linda Fabel: "We have had to overcome a negative image of the RT within the market"

Lagging price/performance

But the RT has continued to lag behind workstations from other vendors in price/performance. Apollo Computer Inc.'s Domain 4500, rated at about 7 MIPS, has an entry-level price of $18,990, while Sun Microsystems Inc.'s Sun-4/110, also with about 7 MIPS performance, has a starting price of $18,900. "It's been a dollar long and a few MIPS short throughout its life," Foundyller says of the RT.

Based on an IBM proprietary reduced instruction set computing (RISC) architecture, the RT hardware is also incompatible with the rest of IBM's computer systems. Another technical Achilles' heel is that its graphics are poorly integrated with the rest of the system, according to several analysts and industry competitors.

But the RT has suffered from marketing shortcomings as well. Foundyller points to IBM's own view of the RT as little more than a high-end PC. "They didn't really understand that they were competing with the Apollos, the Suns and the Hewlett-Packards," he says.

Symptomatic of that was the original name of the product, the "RT PC." Last August IBM dropped the "PC" in an effort, "to restructure the thinking of the end user to look at the RT more as a technical workstation and less as a high-end PC," Fabel says. The move was seen as a response to criticism that IBM has failed to clearly distinguish the RT from its Personal System/2 line.

Nevertheless, the IBM logo alone has been enough to sell the RT to some users. "It has the family connections," Foundyller says, "all it needs is some power. It's a Dan Quayle."

Several research firms, including International Data Corp. and Dataquest Inc., put total sales of the RT at around $300 million in 1987, the last full year for which figures are available. But the consensus among industry watchers is that about two-thirds of all RTs are sold as multiuser systems — particularly in Europe, where Unix is more readily accepted for commercial applications — with only one-third sold as standalone workstations for traditional CAD/CAM applications.

International Data Corp. analyst Vicki Brown calculates that in 1987, sales of RTs as single-user workstations generated $102 million in revenue for IBM, giving the company a 3.9% share of the $2.6 billion workstation market worldwide. She puts the sale of RT workstations in 1986 at $48.3 million, giving IBM a 4.1% share of that year's $1.2 billion market. Although statistics are not yet available on how much of the estimated $3.9 billion workstation market IBM captured in 1988, analysts do not believe the vendor's market share has changed.

Missing out

While $300 million in sales would be considered respectable for many vendors, it represents just 0.55% of IBM's 1987 revenue of $54 billion. But IBM realizes that it is missing out on a huge market unless it becomes serious about the RT, says Prudential-Bache Securities Inc. analyst Rick Martin. He notes that the workstation market is expected to grow over 30% this year, much faster than the mainframe and PC markets — which the analyst expects will grow 8% and 17%, respectively, in 1989 — where IBM makes its living.

"If they don't become a major player in the workstation market, IBM will be relegated to single-digit growth," Martin foresees. "We believe they will be fairly aggressive in trying to gain a share of that market."

So what does IBM have up its sleeve for the RT in 1989? Fabel will only say that the company has "dramatic development plans for the RT." Martin says his information is that IBM plans to boost the performance of the workstation to between 15 and 20 MIPS, while Foundyller says he has been told by IBM executives that the more powerful RTs will be "competitive with anything that is out there."

"They are very serious about it," Foundyller says. "They just haven't got it right yet." Looking even further ahead, a Salomon Brothers Inc. research report projects the RT to have the power of a 3090 Model 200E mainframe — about 32 MIPS — by 1990. Foundyller adds that IBM executives are even talking about a system in the range of 100 MIPS by 1992 to 1993.

IBM realizes it is missing out on a huge market unless it becomes serious about the RT

Recent technology deals with Silicon Graphics Computer Systems and Next Inc. also offer additional evidence that IBM is serious about improving the RT. IBM is expected to add Silicon Graphics' "Iris" three-dimensional graphics products to the RT and has licensed Next's "NextStep" user interface and developer tool kit for possible use with the workstation.

IBM is looking to overcome the incompatibility issue through the use of AIX, IBM's version of Unix. AIX applications for the PS/2, RT and 370 mainframes will be source-code compatible and only require recompiling to run on each architecture. "We have very deliberately defined the high-end PS/2s (the 80386-based Models 70 and 80) and the RT as an AIX family," she says. AIX for the PS/2 is due this quarter, according to Fabel.

Further evidence of IBM's intentions came last month when the company created the Advanced Workstations Division to oversee RT development efforts. The move followed the departure of president William Lowe and the break-up of the Entry Systems Division which previously had jurisdiction over the RT.

Research and development on the RT and AIX are combined at IBM's Austin, Texas, facility. Although IBM has described its AIX development effort as a massive project, Fabel does not disclose the amount of resources devoted to the RT.

IBM's advantage

On the marketing side, IBM has an advantage in that it is generally acknowledged to be the No. 1 vendor in the CAD/CAM arena, with Daratech estimating its share of the $5.2 billion market in 1988 at 25.4%. The company holds that market position with its mainframe computers running such CAD/CAM software as CATIA, CADM, CAEDS and

Your move, Mentor

A decision by Mentor Graphics Corp. to add an IBM, DEC or Sun workstation to its product line will go a long way toward boosting the fortunes of that vendor in the workstation market.

Mentor, a $300 million supplier of design automation systems based on Apollo Computer Inc. workstations, is considering adding a second platform to its arsenal sometime this year. While a workstation from Sun Microsystems Inc. may have been the clear choice in the past, Mentor president Gerry Langeler says the decision is no longer an easy one.

"It's been kind of a nice, simple, easy-to-understand battle," Langeler says of the workstation market to date, and that until now, Sun was the obvious alternative to Apollo. "Sun will still be a good choice in 1989, but it may not necessarily be the obvious choice."

Although adding a second platform is not a certainty, Mentor is "putting all the steps in place if we choose to do so," Langeler says. Mentor has been briefed on future products by Digital Equipment Corp., IBM and Sun, which the president calls "the three most obvious choices."

A second platform would incrementally increase Mentor's sales, Langeler says, but he acknowledges that it would likely cannibalize some of the vendor's sales of Apollo workstations as well. ☐

CIEDS, and that user base could provide fertile ground for RT sales.

Fabel says IBM will continue to target both technical and commercial markets for RT sales. Although she says third-party sales of the system began to pick up in 1988, she admits: "Clearly, we would like to have more resellers utilize it and remarket it." IBM now has several hundred remarketers that carry the RT, Fabel estimates, but she acknowledges that some sell the workstation in relatively small quantities.

IDC's Brown says IBM is "having trouble convincing people that they are serious about workstations. They have to overcome the perception that IBM is not a workstation player and that their products are subpar." Fabel concurs by saying: "We have had to overcome a negative image of the RT within the market."

Despite IBM's presence in the CAD/CAM market, Brown says technical computing accounts for only 10% of the company's sales and that the vendor's real marketing strength lies in the commercial area.

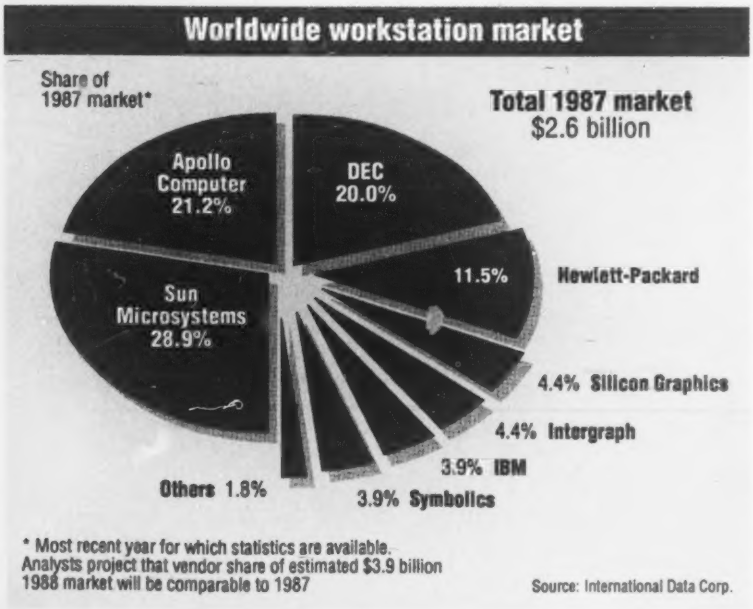
Yet, that is seen as an advantage by William Zarecor, executive vice president of workstation vendor Intergraph Corp.'s Clipper Products Division. He maintains that information system managers, with which IBM wields great influence, often do the computer buying for both commercial and engineering departments.

"The question, as is often the case with IBM, is how they are going to position it," Martin says, referring to the pricing of the new RTs. He says that if the pricing is competitive, "there is no reason for them not to be successful." Fabel says IBM plans to hold RT prices at their current level while increasing the performance.

Digital Equipment Corp. soon is expected to debut its first workstations based on RISC microprocessors from MIPS Computer Systems Inc. Martin believes that if those systems are competitively priced, IBM will have to follow suit, in turn setting the tone for the whole market.

How else will the workstation arena be affected by a competitive RT? While Foundyller says that such a product could boost growth for the overall market by making it "more respectable," he believes a powerful RT will turn up the competitive heat on other workstation vendors. "I think it will hold back the growth of the strong and wipe out the weak," he says.

Dataquest Inc. analyst David Burdick is more skeptical. "Right now it's difficult to see how IBM is going to be a player with the RT. It's hard from my point of view to see how the RT is ever going to become an overnight success."


Worldwide workstation market

* Most recent year for which statistics are available. Analysts project that vendor share of estimated $3.9 billion 1988 market will be comparable to 1987

Source: International Data Corp.

Other workstation vendors profess to be unworried by the prospect of a suddenly more competitive IBM, even though Mentor Graphics Corp. president Gerry Langeler says that, "To count IBM out in any computer market is foolhardy."

Offensive

As the leader in the workstation market, Sun Microsystems Inc. is the likely target for any workstation offensive. While IBM is not about to put Sun out of business, Foundyller says a strong RT could limit the growth rate of the high-flying Mountain View, Calif., company and force it into the secondary role that Apple Computer Inc. now plays opposite IBM on the PC stage.

"I think it's natural for competitors to target the leaders in the market and at this point I don't think IBM can ignore what Sun has done," says Cheryl Vedoe, marketing director for Sun's workstation division. While also acknowledging that Sun cannot afford to ignore IBM, Vedoe says Sun's game plan for remaining in front is to continue its current strategy of staying "on the leading edge of technology."

Market-watcher Martin believes that if IBM's pricing is very aggressive, Sun may be forced to respond. That could hurt because Sun, in its efforts to quickly gain market share, is operating on very thin profit margins.

"So far, [the RT] has not been a serious competitor in the workstation market," says Don McInnis, vice president of DEC's engineering systems group. He argues that the workstation is incompatible with the rest of IBM's product line and that technical computing is not IBM's strongest market. "I think that even if they had a stronger product, the RT would still have some fundamental problems."

"I think [a stronger RT] will make the workstation market more competitive," says John Thompson, senior product manager for personal workstations at Apollo. But he echoes executives at Sun and several other workstation companies by arguing that it is easier for smaller vendors to maintain a technological lead over giants like IBM. ☐

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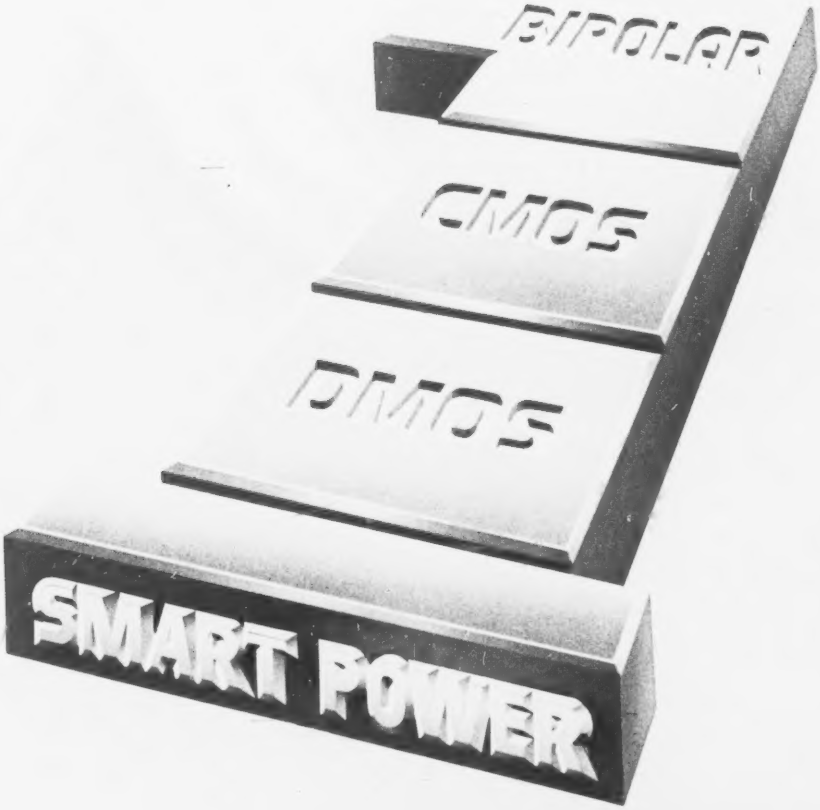
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Where's that recession?

It likely won't show. What will show in 1989 is a moderate contraction — unless Bush continues to ignore deficit realities

BY JOHN KERR

There's never been a recession like it. Books have been written about it. Careers have been built on it. People have died waiting for it. The funny thing is, it's the recession that hasn't even happened.

Continuing one of the longest peacetime economic expansions ever, 1988 closed with a U.S. economy that looks as healthy as can be. Growth in the gross national product is robust; the merchandise trade deficit is expected to drift down to $135 billion for the year; exports are on the up; and a pro-business George Bush joins the White House gang two weeks from now.

The trouble is, the good times won't last a lot longer. While they won't about-face into awful recession — defining recession as negative economic growth in three consecutive quarters — they will lose their shine as the economy backs into a slow-growth mode. The electronics sector, the largest in the U.S. manufacturing industry, cannot expect economic amnesty, either. With deficit difficulties rampant, nobody asks "How come?" any more. The only questions are how soon, how slow and how long.

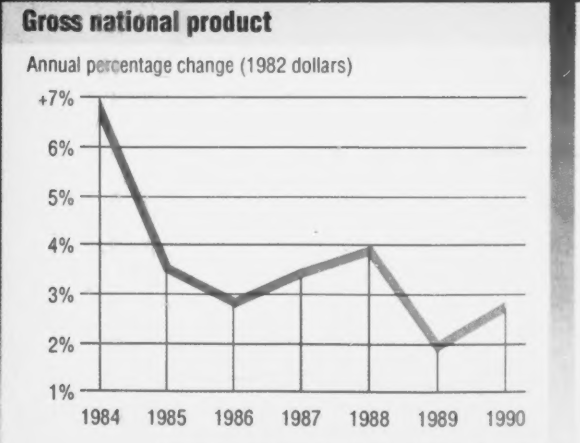
Warns Gilbert Amelio, president of Rockwell International Corp.'s Communications Systems division: "The so-called strong economy we've been experiencing is paper-thin."

The oracles have fingered 1989 as the turndown year for over a year now. Many of the more sinister omens are beginning to line up: national unemployment rates had, by mid-November, dropped to 5.3%, breeding rumors of inflation and fears of reactive interest rate hikes; trade and federal budget deficits showed up, bloated and still hungry, at Bush's door; and the background muttering over America's fiscal irresponsibility is beginning to rise to a growl everywhere from Tokyo to London to Rome, prompting concern that soon — very soon — *something must be done.*

So far, something is not being done. Hobbled by its own "Read my lips, no more taxes" manifesto, the incoming Bush regime shows an alarming apathy toward those twin terrors, the obese budget and trade deficits. One week after Bush's electoral victory, Federal Reserve Board chairman Alan Greenspan was warning that the United States cannot grow its way out of the budget deficit.

It's not clear how much the

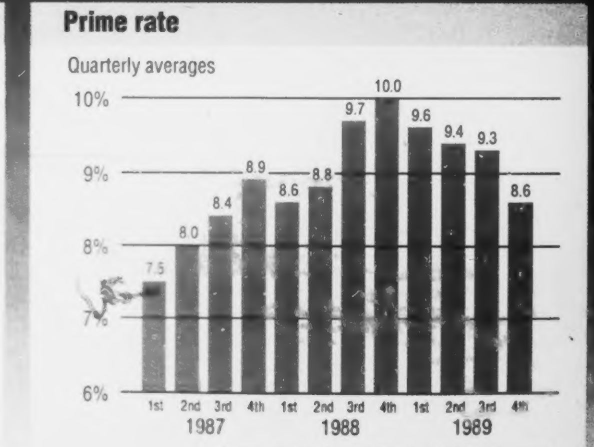
The economy



Gross national product

Annual percentage change (1982 dollars)

Sources: U.S. Commerce Department and Cahners Economics



Prime rate

Quarterly averages

Sources: Federal Reserve Board and Cahners Economics

Gramm-Rudman budget-balancing laws might curtail calamity: Congress seems far too resistant to the notion of across-the-board cuts. What is clear is that much depends on tax action — even if Bush doesn't admit to it being called that. According to Edward Henderson, president of Sunnyvale, California-based forecaster Henderson Ventures, the Fed chairman may soon be compelled to give America's chief executive a tough ultimatum: "If you don't raise taxes, I'm going to have to raise interest rates." And next to taxes and inflation, interest rates are the scariest thing going to most U.S. businessmen.

Most bets are that the new administration *will* hike taxes: Henderson predicts a 90% chance that consumer-oriented (read spending side) "revenue enhancements" will be in effect by midyear.

Crucial harbinger

There is one event that will be a crucial harbinger: the president's economic report, due out later this month, which details the nation's budget for fiscal 1990. "If there's nothing in there about deficit reduction, then we've got some real problems," says David Wyss, chief financial economist at Data Resources International (DRI) in Lexington, Mass.

The specifics are clear: America's gross national product (GNP) will inch up just 1.9% this year, compared with the 3.9% rise seen last year and 3.4% step in 1987, according to Cahners Economics, the economic research arm of Cahners Publishing Co. Inflation, based on consumer prices, will jump the 5% bar this year, helping to puncture consumer confidence. Growth in business investment dollars, according to Cahners, will fall back to 1.7% this year after a 9.4% surge in 1988. And growth in total industrial output will go negative, shrinking by 0.2% in 1989.

One source says there's a 90% chance that Bush *will* hike taxes by mid-1989

The U.S. electronics industry will mirror the trend. The ELECTRONIC BUSINESS leading indicator, an economic pointer that predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime, is heading inexorably downward, a slide it began in October 1987.

Last fall, the semiconductor sector's order bookings fell below the level of orders that it was shipping, a pattern that Cahners sees worsening in the second quarter of this year. Computer sales — even in previously fast-paced PC and workstation segments — are taking a breather as users sort out the mixed messages coming from the folks setting computer operating standards.

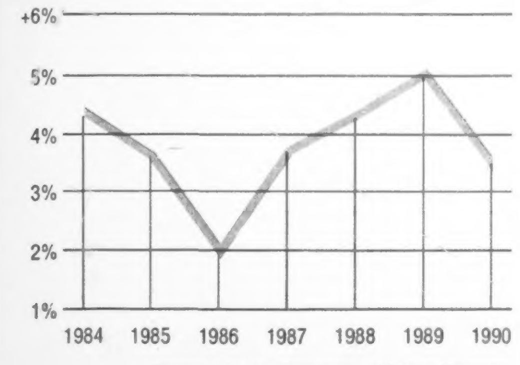
Overall, Cahners points out that 1989 will show almost no growth in U.S. shipments of electronics goods — a gain of just 0.8% that pales beside last year's 9.3% jump. And U.S. electronics production, Cahners says, will continue the gradual descent begun early in 1989, hitting the bottom of the curve sometime in the third quarter.

While the inevitability of a downturn is not in debate, its timing is. Others sense that business will head south no earlier than the last quarter of this year. According to Henderson Ventures, total U.S. electronics equipment production will still show a 6.5% gain over 1988, but 1990 will slow to a 3.3% annual percentage rate increase. Computers and office equipment will show one of the sharper slowdowns, from a 1989 boost of 8.4% to just 2.9% growth in 1990.

DRI is indicating that the first quarter of this year will show good results, but senior forecaster Wyss maintains that it'll be the last strong quarter for at least a year. He confirms that 1989 will be a slow year, but not a recessionary one: GNP growth will wilt from 4% last year to about 2.5% — the same level pre-

Inflation

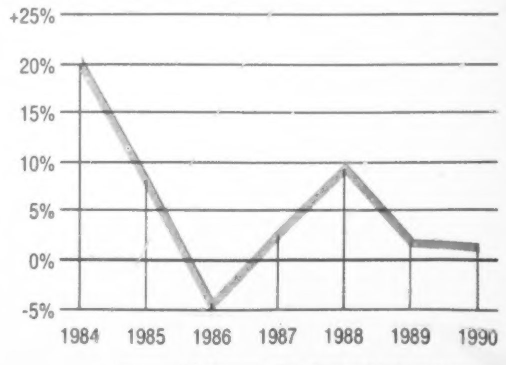
Annual percentage change in consumer prices



Sources: U.S. Labor Department and Cahners Economics

Business investment

Annual percentage change (1982 dollars)



Sources: U.S. Commerce Department and Cahners Economics

dicted by the consensus of economists polled by Sedona, Arizona-based Blue Chip Economic Indicators. DRI adds that the level of business investment growth will back off from last year's 18% surge to 6%. "Six percent isn't bad, but it's not 18%," says Wyss.

Lost computer momentum

Wyss' analysis of the downturn points to lost momentum in computer sales: last year, growth in production equipment, much of it computer-driven, provided 1.5 percentage points of total GNP growth, but this year, as unsensational replacement business becomes the dominant pattern of computer purchasing, it will drive a small fraction of GNP gains. "We're running out of new people to buy computers," notes Wyss.

A real fear, maybe just as factual as emotional, may come from an ailing dollar. Plunging close to a 40-year low against the Japanese yen one week after the presidential elections, the once-mighty greenback prompts deep concerns that it will fall much further — as low as ¥110 by year's end, warns DRI's Wyss. While that would clearly give exports another spin, it could be the crisis that forces the dollar into understudy status on the world currency stage.

Sounds gloomy? Sure it is. But it's not anything to get suicidal about: a second reading of the statistics reveals several solid fundamentals.

First, the forecasts are talking about growth rates, and just because there's been a decline in growth of electronics production or shipments of electronics equipment doesn't mean that there's no growth at all. A 1.7% increase in U.S. business investment dollars is an increase nonetheless.

Second: technically, this won't be a recession — it'll be more properly termed "a contraction," a downturn that won't bite too deeply. Some sources go so far as to indicate that there is no short- to medium-term likelihood of economic crisis even if the new administration does procrastinate on the budget deficit. In a mid-November report issued by the Brookings Institution, the Washington think tank, the authors concluded that America can probably muddle through, its growth financed by foreign investors.

The inevitability of a downturn is not in debate, but the timing is

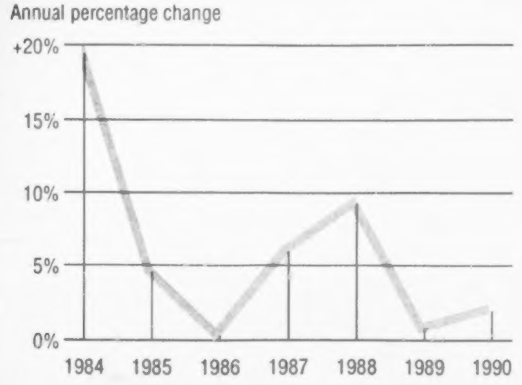
Cahners points to several more immediate reasons to be cheerful. Electronics shipments *will* recover, gaining 2.1% in 1990. Electronics distributors' shipments will come back more strongly still, with a positively buoyant 5.3% gain. The GNP will climb 2.7% and total U.S. industrial output will pick up 3.6% in 1990, and the prime interest rate, peaking at 10% in 1988's last quarter, will step down to an alluring average of 8.6% in the fourth quarter of this year. It'll hardly provoke dancing in the streets, but it's good news for much of the electronics industry, where cost of capital has become more and more of a worry.

The deficit manacle

But it'll be hard for Bush to dance with a deficit manacle on each ankle. The federal shortfall remains huge; the post-election noises from overseas hint that foreign nations may not have the confidence to invest indefinitely in the perceived strength of the Untied States' economy. The trade gap promises to be much tougher to whittle down than its recent diet might suggest.

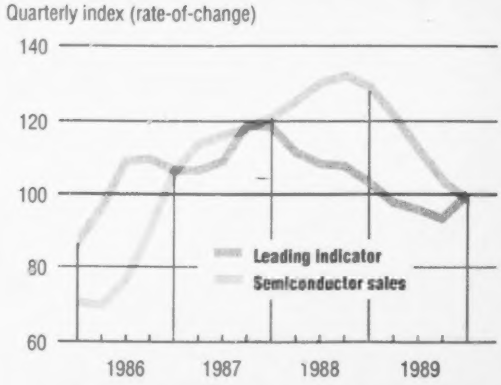
A lot now rests on the big shoulders of the next U.S. president. If he acts promptly to at least acknowledge the extent of the economic imbalances, the Brookings Institution forecasters will certainly be proved right. If Bush insists that Americans keep reading his lips, the United States could be faced with the worst of both worlds: a 1990 recession *and* no cure for the deficits. □

Electronics shipments



Sources: U.S. Commerce Department and Cahners Economics

ELECTRONIC BUSINESS leading indicator



Sources: Semiconductor Industry Association and Cahners Economics

Computer makers batten down for '89's tough times

Technology turmoil and economic uncertainty are squeezing mini and mainframe sales growth and braking PC and workstation sales

BY RICK WHITING

While far from the deep slump that hit the U.S. computer industry in 1985 and 1986, manufacturers are battening down the hatches in anticipation of a slowdown in nearly all segments of the industry in 1989.

U.S. shipments of computer equipment and office machinery grew about 12% to $68.6 billion in 1988. But economic uncertainty and evolutions in technology are expected to hold growth to a miniscule 1.2% in 1989, with total shipments climbing only to $69.3 billion, according to forecasts by Cahners Economics, the economic research unit of Cahners Publishing Co.

"There is some anticipation that 1989 is going to be a rough year," says Charlotte Walker, an analyst with County Natwest Securities USA. "All the signs show that demand is slowing."

Domestic sales of computer equipment are expected to remain in the doldrums, where they were for much of 1988. Although that was offset by increased international sales for many vendors, there are some signs that overseas sales growth may also moderate in 1989.

Spending for capital equipment by the manufacturing sector remains strong, although analysts detect an overall slowdown in capital equipment spending within the U.S.

Prime Computer Inc.'s experiences are typical. Prime expects its sales to the manufacturing sector to grow between 13% and 15% in 1989, but sales to the financial services and government sectors of the economy will likely remain "sluggish," according to Richard Goldman, CFO.

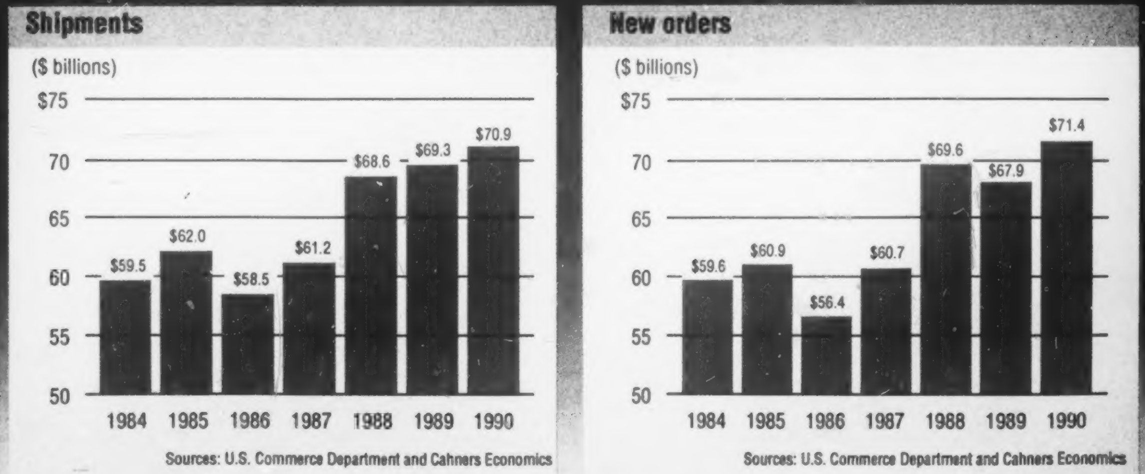
Customers confirm slower buying patterns. Marathon Oil Corp., which buys mainly DEC computers, is holding the line on expenditures for computer equipment in 1989. Given the uncertain oil market, the company's $3 million budget for scientific computer purchases this year is flat with 1988 expenditures, according to Michael Heagney, supervisor of worldwide systems and operations with Marathon's Exploration Computing Systems Group.

Analyst Walker says that for computer manufacturers, the trick will be to build sales and support infrastructure and continue research and development efforts for future growth, while keeping profit margins from sinking out of sight.

On goes the slump in minis

The slowdown in minicomputer sales that hit manufacturers in 1988 will continue into 1989, industry watchers say, with market growth continuing at the same sluggish 7%

Computers and office machinery



Sources: U.S. Commerce Department and Cahners Economics

Sources: U.S. Commerce Department and Cahners Economics

to 8% rate the industry saw in 1988. Sales growth for mainframe systems is also expected to hover at the same 5% to 7% pace of last year. International Data Corp. estimates that in 1988, total U.S. sales of minicomputers and mainframes reached $17.2 billion and $9.5 billion, respectively.

Minicomputer vendors are trying to sell systems into a saturated market, according to First Boston Corp. analyst Susie Peterson Case. "I think there is already a lot of hardware out there," she says. Particularly hard hit are high-end systems sold by Digital Equipment Corp., Prime, Tandem Computers Inc. and others.

Slower workstation sales

Workstations will likely remain the fastest growing segment of the computer industry, although slowing from the breakneck pace of 1988. Estimated worldwide sales of workstations last year were $3.6 billion, according to Dataquest Inc., with the Untied States accounting for about 60% of that. Industry watchers are still expecting workstation sales to grow anywhere between 25% and 50% in 1989. But DEC and IBM are expected to unveil more competitive workstation products during the year, turning up the heat on Apollo Computer Inc., Sun Microsystems Inc. and other vendors.

After showing a gain of 34% in 1987, personal computer revenue growth slowed in 1988 to an estimated 22%, according to Prudential-Bache Securities Inc. analyst Kimball H. Brown, who expects worldwide microcomputer sales growth to slow further to an estimated 17% in 1989. Dataquest estimates put total PC sales in the U.S. at $22.4 billion in 1988 and $24 billion in 1989.

What's more, this year is expected to be particularly difficult for so-called "second tier" PC vendors, while market leaders IBM, Apple Computer Inc. and Compaq Computer Corp. will increase their share of the microcomputer market. "The big will get bigger and the weak will get beat up," Brown predicts, noting that AST Research Inc., Wyse Technology and others are beginning to experience slower sales.

Users will likely spend much of 1989 assimilating the PCs bought since 1987 before buying new ones

Aside from economic factors, 1989 is expected to provide more than its share of hot issues on which the performance of various industry segments will hinge.

In the frantic personal computer market, the slow ramp-up of the OS/2 operating system and the continuing debate over IBM's Microchannel versus the proposed Extended Industry Standard Architecture (EISA) will create uncertainties among customers and hold down sales growth.

Higher prices for DRAMs and other components will also squeeze profit margins and prevent vendors from lowering prices and stimulating demand. And after buying huge numbers of microcomputers in 1987 and 1988, users are also expected to spend much of 1989 assimilating those products before making additional purchases.

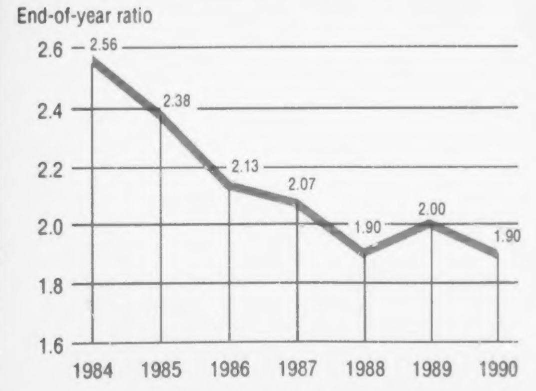
In the minicomputer arena, the transition from large host-based systems to desktop systems connected to network-based servers will force minicomputer makers to reevaluate their strategies and look to other areas for revenue growth.

DEC already plans a major push into the workstation market this year to help compensate for slow minicomputer sales. Systems software is expected to account for an increasing percentage of computer vendors' revenue, and many traditional hardware manufacturers will broaden their offerings to include systems integration and other services.

The continuing imbroglio over Unix, the RISC versus CISC debate and other issues will likely dominate 1989 as they did 1988 and further blur the sales growth picture for workstations and minicomputers. ☐

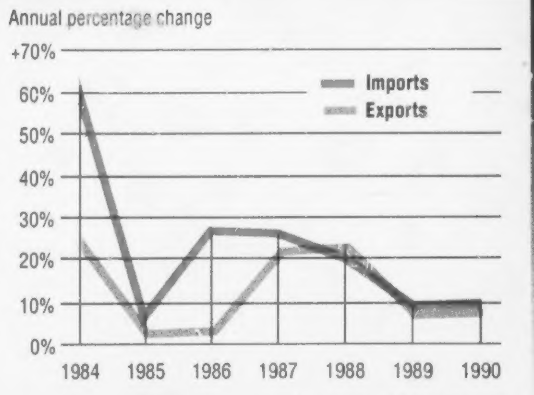
Computers and office machinery

Inventory-to-shipments ratio



Sources: U.S. Commerce Department and Cahners Economics

Trade



Sources: U.S. Commerce Department and Cahners Economics

Call waiting: Sales of telecom gear level off

Slack telecom equipment sales will be offset by continued gains in datacom. LANs, T-1 multiplexers and ISDN chips are the hot wires

BY ANNE KNOWLES

In an effort to educate its customers, AT&T recently ran an advertisement comparing today's plain old telephone service, wittily labeled POTS, to the futuristic Integrated Services Digital Network, or ISDN. Changing from the plain old telephone service to gloriously new and improved ISDN, says the ad, is like switching from a Model-T to an F-16 jet fighter. The ad then asks the question: You may have your driver's license, but are you ready to fly?

If the near-term outlook for the telecommunications industry is any indication, then the answer is apparently no. Widespread use of ISDN — which allows the transmission of voice, data and video over the same telephone lines — is a few years away. Meanwhile, the industry is in a transition period while it makes way for the future. As the ad explains, the switch to ISDN is an evolutionary process that will utilize existing equipment. As a result, large ticket items will experience little to no growth, while smaller, niche markets that are helping to pave the way forward will expand rapidly.

The datacommunications market is ready to soar. Users interested in tying together their computers, peripherals and other devices through networks are willing to spend money to do so.

In 1989, the U.S. telecommunications industry — equipment plus services — should grow 3%, to $141.5 billion, according to Dataquest Inc., a market research firm.

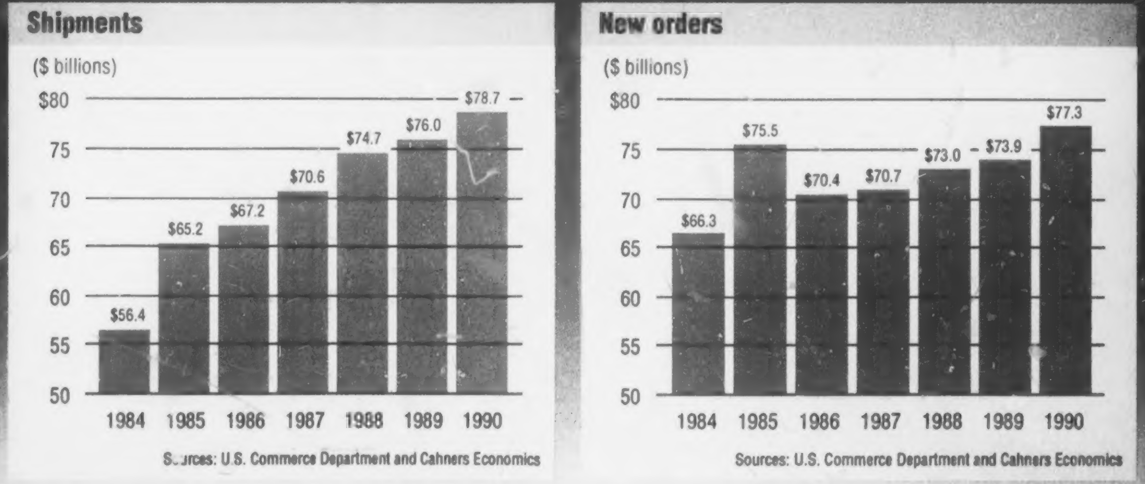
This slow-growth trend line applies particularly to communications equipment, as Cahners Economics, the economics research arm of Cahners Publishing Co., points out in its interpretation of U.S. Commerce Department statistics. According to Cahners, U.S. shipments of communications gear will inch up just 1.7% to $76 billion worth this year, compared with the 5.8% growth evidenced in 1988.

Dataquest's studies show that the services side of the U.S. market, which includes local, long-distance and public data services, will grow 3% to $130.2 billion. Public data services such as packet-switching and electronic mail should increase 5% to about $460 million.

But selected equipment sectors show more promise. Because packet switching is becoming more popular for global communications, says Katharine Korostoff, an analyst with International Data Corp. in Framingham, Mass., the U.S. packet-switching equipment market should climb about 12% to $282.9 million in 1989.

The public equipment piece, which includes transmission and switching

Communications equipment



Shipments

Sources: U.S. Commerce Department and Cahners Economics

New orders

Sources: U.S. Commerce Department and Cahners Economics

gear purchased by AT&T, the Bell Operating Companies and other common carriers (OCCs) such as MCI Communications Corp. and U.S. Sprint Communications Corp., is expected to rise 4% to $11.3 billion. The brightest spot in that segment is the U.S. market for fiber-optic equipment, projected to climb 20% to about $1.2 billion in 1989.

Specifically, U.S. sales of fiber-optic transmitters and receivers will be about $288.8 million, growing 35.2% compounded annually through 1992, while U.S. sales of fiber-optic connectors should climb to $46.6 million this year — this according to the Information Network, a market research firm in San Francisco.

Stagnant PBX sales

According to Dataquest, the business, or private communications market, which includes private branch exchanges (PBXs), key telephone systems and voice messaging, will reach $8.4 billion this year, 5% above last year's U.S. market. Stagnant sales of PBXs, estimated to be the same as last year's $3.1 billion, reflect the market's status as primarily for replacement and upgrade.

Upgrading PBXs to take advantage of ISDN is fueling a small but fast-growing market for ISDN chips. According to the Information Network, U.S. revenue from ISDN chips will reach $37.6 million in 1989, growing 303.8% compounded annually until 1992, when ISDN chip sales will hit $1.2 billion. The fastest growing application segment for the chips, says Robert Castellano, president of the market research firm, will be PBX conversion. The Baby Bells, all of which are currently undergoing or planning ISDN field trials, are the largest customers for the chips, he says.

Now for the best news. According to Dataquest, the datacommunications market in the United States will jump 18% to $7.2 billion this year. Despite the rosy outlook, some segments of the market are doing poorly. Sales of modems, for example, should drop 8%, to $1.2 billion, due in part to IBM's fall announcement of a 15-member modem family that will drive down prices in that market.

The U.S. packet-switching equipment market should climb about 12% to $282.9 million in 1989

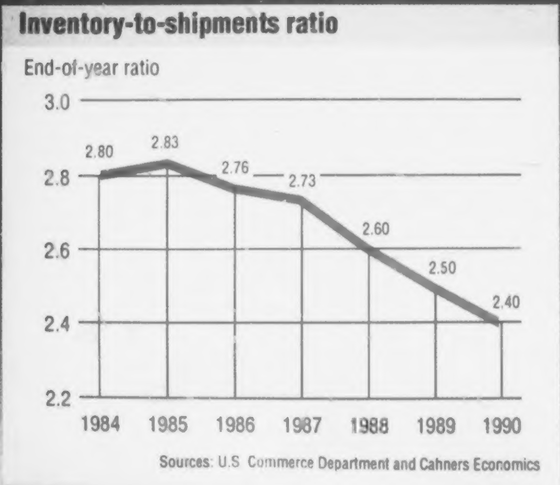
But expected revenue in other areas of the U.S. datacommunications market will pick up the slack. Sales of T-1 multiplexers — digital transmission devices and lines that can handle voice or data or both at rates of up to 1.544 megabits per second — will jump 24% this year, to about $500 million. The highest growth for the industry is expected in the market for local area networks which should increase 39% to $3.6 billion, says Dataquest.

Fiber-optic LANs based on the Fiber Distributed Data Interface, or FDDI, will start having an impact on the market this year. Fibronics International Inc. last fall announced the first FDDI product — an Ethernet-to-FDDI bridge — using Advanced Micro Devices Inc.'s SuperNet FDDI chip set. AMD, which has a cross-licensing arrangement with Siemens AG for the chip set, currently has 50 beta sites for the product. The only other vendor offering FDDI chip sets is The Plessey Company Plc.

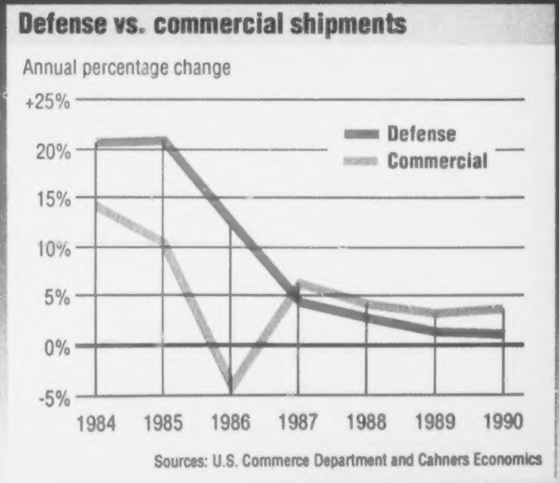
Revenue from fiber-optic LANs is expected to reach $84 million in 1989 in the United States, according to the Information Network. That figure includes sales of star-based and bus-based LANs; it does not include LANs based on token ring topology, such as FDDI, because such LANs have only recently been introduced.

However, the proliferation of LANs is driving the market for network management — a diversified set of hardware and software products designed to monitor and manage equipment on a network. According to IDC, U.S.-based vendor product revenue will grow 20% to $231.2 million this year. ☐

Communications equipment


Inventory-to-shipments ratio

Sources: U.S. Commerce Department and Cahners Economics


Defense vs. commercial shipments

Sources: U.S. Commerce Department and Cahners Economics

Slip yes, slump no for U.S. chip makers

With customers' inventory levels under control, U.S. chip makers can expect a 3% contraction in sales in 1989 but no replay of 1985

BY VALERIE RICE

Knock on wood, 1989 will not be a replay of the disastrous 1985 for the semiconductor industry.

But, although the market for semiconductors won't hit bottom in 1989, it won't set record growth rates either. Whether this year will be down, flat or slightly up, it certainly won't have the robustness of 1988.

What 1989 may have is a recession. Economists are split on whether the United States will enter a recession in 1989, 1990 or at some point later. So, forecasts for semiconductor growth in 1989 and beyond vary, based on when the expected recession will hit.

Cahners Economics, for example, is not predicting a recession in the next two years, merely a "contraction" in the economy. The Cahners Publishing Co. economics research arm forecasts that semiconductor sales in the United States will drop slightly in 1989 to $12.7 billion, which is down from $13.1 billion in 1988. Worldwide sales will also decline to $40 billion in 1989, down from $42.2 billion in 1988. Cahners predicts that the semiconductor industry will show a modest increase in growth in 1990, with worldwide sales rebounding to $42.8 billion by the end of that year.

The Semiconductor Industry Association (SIA), however, sees 1989 as a year of modest growth, with worldwide integrated circuit sales increasing 12.2% in 1989, and then declining 3.9% in 1990. Others, like market research firm In-Stat Inc., see an essentially flat market in 1989, with a rebound in 1990.

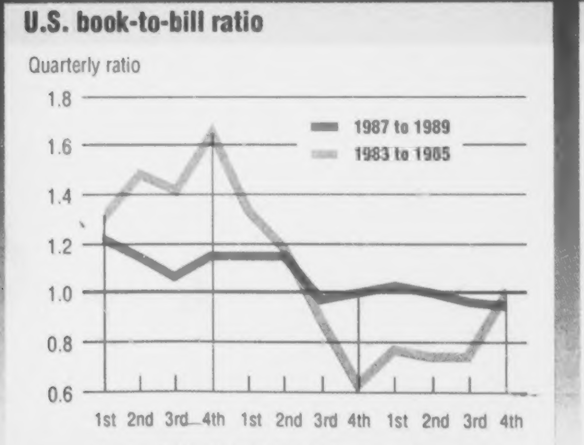
One way to sanity-check whether 1989 will be flat or just plain horrible is to look at inventory levels — that demon instrument of doom for chip manufacturers in 1984-85.

The good news seems to be, however, that inventory levels are more or less where they should be and that customers, far from stockpiling, are actually being reasonable in their orders.

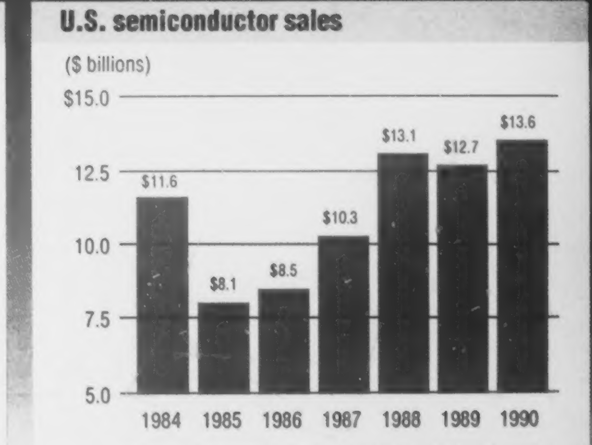
In-Stat's president Jack Beedle notes that thanks to factors like just-in-time deliveries and better inventory tracking systems, customers are buying smarter, and paying more attention to inventory levels than ever before.

Chip companies, too, are carefully watching their customers, and overall, it seems to be working. Fujitsu Microelectronics Inc. recently conducted a survey of its customers' inventory levels, according to senior vice president and general manager Richard Christopher. Through September of 1988, Fujitsu's customers were under their own target levels in

Semiconductors


U.S. book-to-bill ratio

Sources: Semiconductor Industry Association and Cahners Economics


U.S. semiconductor sales

Sources: Semiconductor Industry Association and Cahners Economics inventories and had been under since the first quarter.

"We are seeing only minor inventory growth on passives and certain standard product areas," he says, "but on our types of products we're not seeing any buildup."

Texas Instruments Inc. is also tracking customer inventory levels, according to president Jerry Junkins. In 1982, the average TI customer had 11 weeks of inventory; as of October 1988, the average inventory had dropped to 5.3 weeks. That, according to Junkins, is a piece of good news.

Perhaps the only dissenting voice here is that of Intel Corp.'s microprocessor senior vice president David House.

"We're seeing strange things," he acknowledges. "Inventories are out of whack — too high in some areas, too low in others. Right now there's no way to tell if what we are seeing is the beginning of a downturn, or just inventory-related [fluctuations]," House adds.

This inventory imbalance will negatively impact the company however; first quarter of 1989 sales will be less than expected, due to a glut of 80386's.

Where wild growth is — and isn't

The big winners in 1989 will be cutting-edge technology products, ASICs, telecommunications chips, and not too surprisingly, memories.

In general, CMOS logic and memory products will continue to be strong through 1989, representing an increasingly large share of solid state shipments. Specifically, logic products (including ASICs and microprocessors) are expected to grow 23% in 1989, slowing to 4.3% in 1990, according to the SIA. Memories will come down from their dramatic 185.7% growth in 1988 to a more moderate 49.6% in 1989. But by 1990, the momentum will have slowed, with memories dropping 7.7% that year, according to figures from the SIA.

The winners in '89 will be cutting-edge technology products, ASICs, telecom chips — and memories

Some of this phenomenal growth, particularly in memories and microprocessors, will slow because of the decline in prices. High prices artificially supported the boom in 1988 (some say as much as 10% of the growth can be attributed to prices), so the lessened growth rates in 1989 are not out of line.

At Motorola Inc., microprocessor general manager Jack Browne is expecting a reasonable year, despite the downturn, due in part to the company's broad product line. Motorola's recent reentry into the DRAM market, combined with strong pushes into consumer areas and "good strong growth in the telephony area" should be sufficient to offset what Browne believes will be a down year.

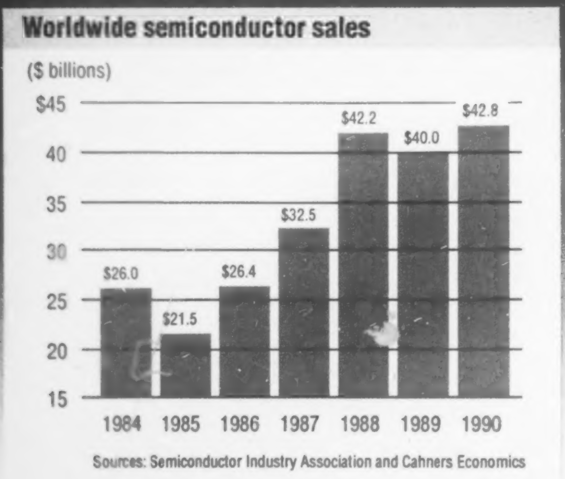
Commodity doubts

One area virtually every analyst agrees on is the inadvisability of dependence on commodity, PC-based products in the coming months.

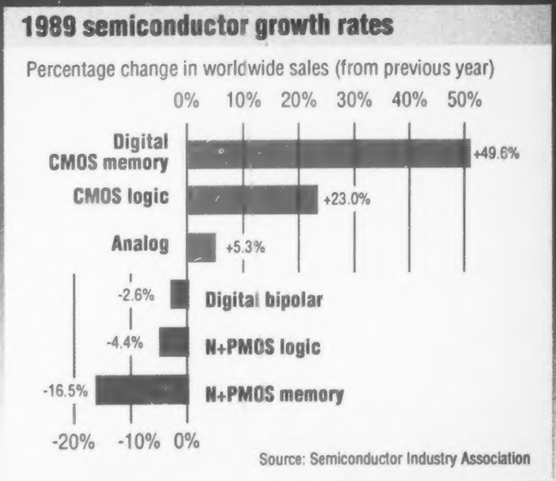
At VLSI Technology Inc., president James Fiebiger is predicting that the "PC market will show some softness, particularly amongst the Asia/Pacific clone makers. We are working closely with the guys in the United States right now, and we think the outlook [for them] is quite strong. But we see some slowing in the Far East."

That view is echoed by Peter Hillen, strategic marketing manager at International Microelectronic Products Inc., who says that his company is "thinking of going into the hamburger business," because 1989 will likely be a somewhat rough year, with a recession proper showing up at year's end. IMP sells a lot of disk controllers, and right now the disk drive market is in the tank, Hillen says. "That was a big ding for us," he admits ruefully. ☐

Semiconductors


Worldwide semiconductor sales

Sources: Semiconductor Industry Association and Cahners Economics


1989 semiconductor growth rates

Source: Semiconductor Industry Association

Capacitors lead the components charge south

Expect scant sales growth in switches, and an actual dive in capacitor business. Relays should hold up, as will connectors

BY JOHN McCREADIE

For many makers of resistors, capacitors, switches, relays, connectors and other passive components, the tough times are back.

They won't be nearly as tough as the dark days of 1985 — inventories have stayed under control and leadtimes are down — but 1989 is still going to show a slowdown in many sectors. The overall pattern is seen in the interpretation of U.S. Commerce Department statistics by Cahners Economics, the economics research arm of Cahners Publishing Co.: U.S. shipments of electronics components (including semiconductors — see separate article) will slip from last year's $55 billion to $53.9 billion.

The patterns are the same for specific passive-component segments: capacitor sales, predicts Cahners, will fall 5.1% this year, a sharp reversal of the 14.2% upturn seen in 1988. Another market researcher, Venture Development Corp., foresees limited growth in U.S. shipments of switches, up from last year's $1.33 billion to $1.39 billion.

However, there are some pockets of better business performance. Relays, according to Venture Development, will produce U.S. shipments of $1.26 billion, up from 1988's $1.15 billion. And U.S. electronics firms will prove hungry consumers of connectors and IC sockets, gobbling up $4.48 billion worth in 1989, compared with $4.19 billion last year.

Also, sales growth is being sustained in surface-mount component categories, and in application-specific parts.

Overall, passives makers are looking forward with some caution. The lessons brought by the crash of 1985 are well-seeded as industry players concentrate on keeping tighter inventories and creating shorter leadtimes. But as OEMs continue to trim their vendor lists, this mature industry is being rattled by acquisitions, foreign competition and ever-increasing demand for top quality. All of which is forcing passives vendors into sweeter relationships with their customers.

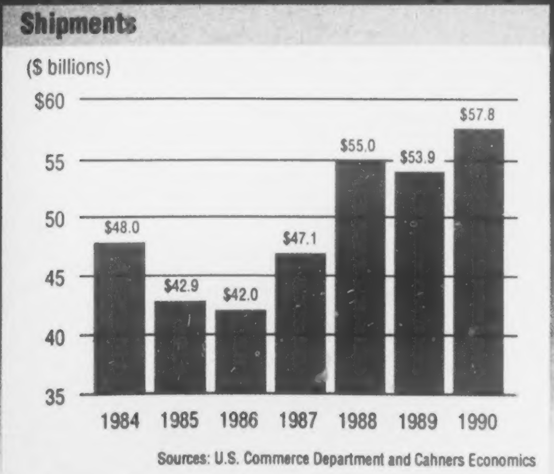
"The IBMs and big auto makers always thought they could beat up the vendors by having them compete against each other to get the lowest possible price," says Dick Kolster, product marketing manager for Siemens Components Inc. "Now, both suppliers and customers are seeking a better working relationship with one another."

Stop the war

Adds Marshall Butler, chairman of capacitor maker AVX Corp.: "The industry is trying to stop the war be-

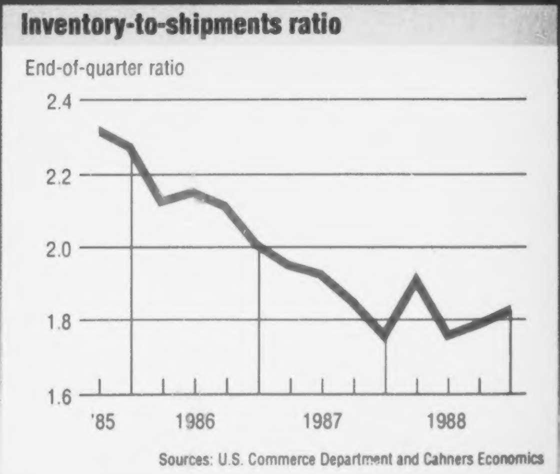
Components

Shipments



Sources: U.S. Commerce Department and Cahners Economics

Inventory-to-shipments ratio



Sources: U.S. Commerce Department and Cahners Economics

tween the vendor and the OEM. They're trying to get their relationship more solid, where quality and service are more important than bombing the price."

Vendors indicate clearly that users are shifting away from price concerns and concentrating more on quality and service. However, price remains an issue. For most market segments, prices remained stable and there they will remain, at least for the first half of 1989, say analysts. One exception will be in the multilayer ceramic area, says Emmitt Graham, a market watcher with Woodside Market Research Inc. This product category, which accounts for most of the capacitors used in electronics applications, will continue to show price declines because of softening in the PC industry.

Beckman Industrial Corp. is counting on another year of price stability, according to Candia Bernstein, market research manager for the resistor manufacturer. "Although by the end of the year, things could be a little soft," she says. Bernstein points out that if prices do fall, the damage will be minimal because component makers are already operating on very small margins.

Leadtimes are being kept trim, too. Helped by improved relations between vendors and users, leadtimes are stable throughout the industry; Cahners Economics expects them to average 5.7 weeks this year, an improvement over last year's 6.2 weeks.

However, most component makers would agree with that forecast, many predicting improved leadtimes are on the horizon which may be a direct result of implementing paperless purchasing systems. Commenting on resistor maker Bourns Inc.'s new electronic data interchange program, Dennis Lause, vice president of electronic component sales for Bourns, says: "We can improve visibility, eliminate errors, reduce paper and speed the whole purchasing process."

> **Component leadtimes are expected to average 5.7 weeks this year, down from 6.2 weeks in 1988**

At Siemens Components, Dick Kolster points to 1988 leadtimes for capacitors between eight and 12 weeks. "We would like to see it a little lower, maybe eight to 10 weeks," he says. At 3M Co., leadtimes are two to four weeks, a dramatic improvement from the six to eight weeks of just two years ago. Kolster adds that inventories are being kept low because "everybody is trying definitely not to get burned." Cahners indicates that the components inventory-to-shipments ratio closed 1988 close to a four-year low.

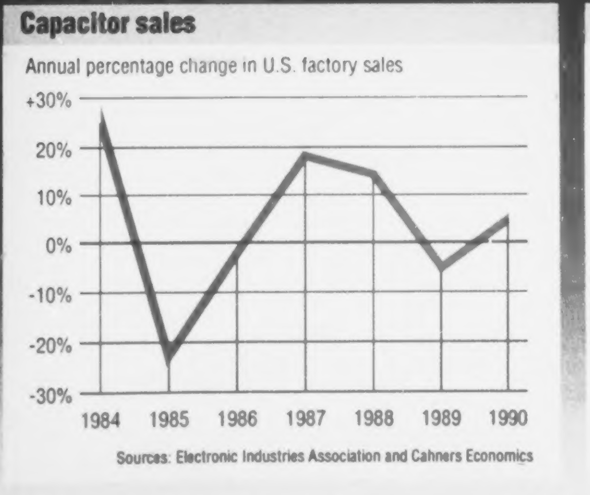
There is little doubt that today's components industry is global. According to Dick Evans, marketing and international director for the electronics division of 3M: "We're experiencing growth outside the United States equal to or greater than our growth inside the United States."

Meanwhile, all component companies are focusing on several key growth areas in the market. The automotive market is rapidly expanding, especially in the area of surface-mount components, says Siemens' Kolster.

SMT continues to evolve as more companies manufacture products using the technology. At Bourns, product marketing vice president Jeff Boyd expects SMT sales to double in 1989. "The good news is it will cross over into most market segments," he says. And worldwide consumption of SMT components is expected to hit $25.1 billion by 1992, according to Electronic Trend Publications, a Saratoga, California-based market research company.

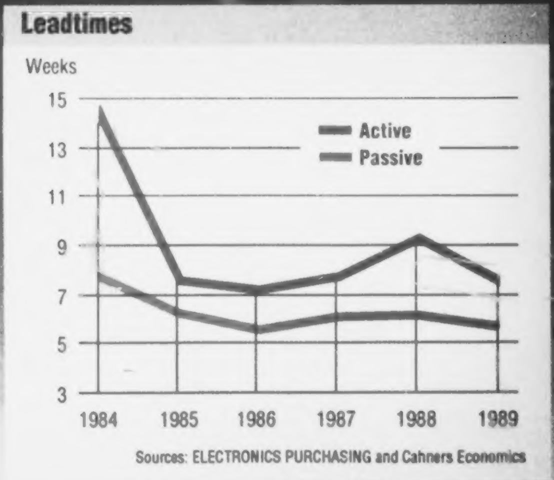
Application-specific (AS) components continue to be a fast-track market segment, and manufacturers relish the higher gross margins there. Connector maker Molex Inc. is currently doing 60% of its work with automotive customers in AS and over 90% is AS in its computers and peripherals markets. ☐

Components



Capacitor sales

Sources: Electronic Industries Association and Cahners Economics



Leadtimes

Sources: ELECTRONICS PURCHASING and Cahners Economics

ATE makers dig in for slow growth year

With just 4.3% growth, 1989 won't be as hot as board- and IC-tester firms might like. Scope vendors should still see strong sales growth

BY TONY GREENE

While 1988 was no banner year for the makers of test and measurement gear, it's a year that will be fondly remembered in 1989. According to market researcher Prime Data Inc., the total world market grew only 12.5% last year to total $7.9 billion. But in 1989, world sales are expected to show an even more lethargic growth rate of 6.4%, bringing the total dollar value of the market up to $8.4 billion.

In its broader analysis of the market for all scientific and engineering instruments, Cahners Economics, the economic research arm of Cahners Publishing Co., sees an identical pattern. U.S. shipments, Cahners predicts, will climb only 3.3% to $50.6 billion worth, compared with a 9.7% upturn last year.

The outlook for ATE is dismal too, notes Cahners, with predicted worldwide sales growth of 4.3% to $2.4 billion in 1989 after last year's 25.8% surge to $2.2 billion. Prime Data analyst Kenneth Neff foresees a tough year for the ATE makers: "I don't think we're going to see a negative year, but electronics is back in phase with the general economy and the economy is going to slow down with GNP growth between 1% and 1.5%."

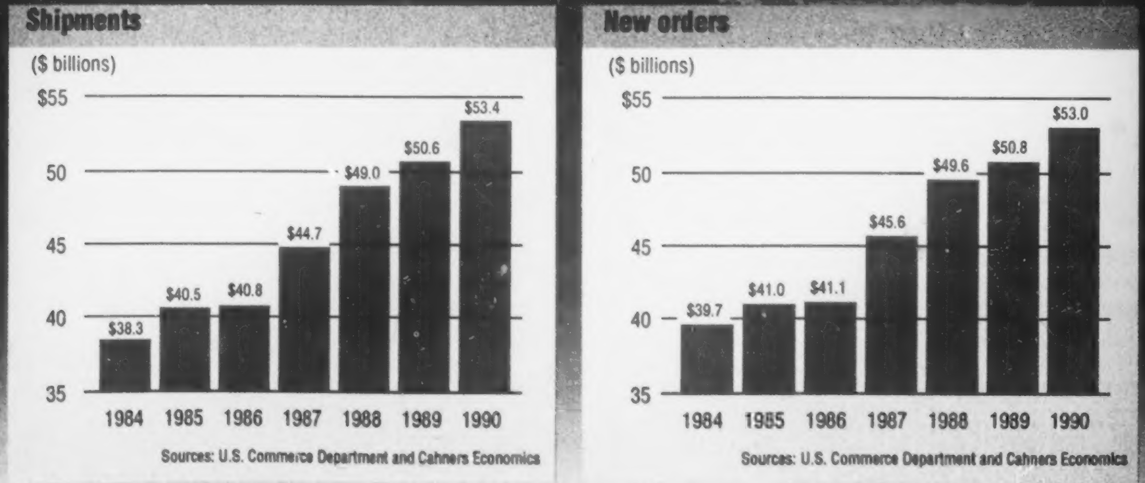
Neff expects the makers of IC test gear to be the hardest hit in the upcoming year, with sales growth of 3% in 1989 after a 27% spurt last year. Board test vendors should fare better, with sales growth down from 12% in 1988 to 5% in 1989. A shakeout remains a good possibility. According to Neff, "ATE firms are lean and mean already. They have control on their growth and they have their houses in order. ATE is already a mature market, but there is the potential for more consolidation."

Vendors of IC test equipment don't plan to be caught napping. Says James A. Prestridge, vice president of the component test group for Boston-based Teradyne Inc.: "There is reason for caution but not pessimism. The year will be flat but could go plus or minus 10%. We are making plans for a flat year."

While most IC test-gear vendors agree that there will be a slowdown, they see good opportunities for growth, especially in particular segments such as memory chips and mixed analog/digital chips for communications uses. "Memory will see substantially higher growth than the logic," says Jim Mulady, manager for sales and marketing for Ando Corp. of Sunnyvale, Calif. "We could possibly see growth of 50% in memory equipment sales, specifically for static memories."

Steve Bisset, president of San Jose-based IC tester company Megatest

Scientific and engineering instruments



Shipments

Sources: U.S. Commerce Department and Cahners Economics

New orders

Sources: U.S. Commerce Department and Cahners Economics

Corp., agrees, and also sees promise in VLSI test. "The growth of the RISC processor area is really taking off. There is going to be enough growth next year so that people who have survived so far will survive 1989," he says.

Pricing wars

That's for those in a position to wage pricing wars. "1989 is going to be a real market share fight year because there is a lot of test equipment capacity . . . The tester wars are going to continue and anybody who does well in 1989 has to gain some market share in the process," says Teradyne's Prestridge. Adds financial analyst Steven Balog of Shearson Lehman Hutton Inc. of New York City, "We have a price war in VLSI test, but at this point it doesn't matter; if you go from 1,000 degrees to 1,500 degrees your goose is still cooked." Others indicate that ATE vendors are coming in at 40% and 50% off to sell a logic tester, with 10% to 20% discounts a phenomenon integral to the industry.

The vendors in board test equiment are viewing things more conservatively. Joseph B. Lassiter Jr., Teradyne's vice president of manufacturing systems says, "1989 will be about like 1988. The board test business will be about flat. In board test we need to learn to live with this volume of sales. We've done a lot of work on margins and other forms of cost reduction." Lassiter also notes that Teradyne has let a healthy backlog build up in anticipation of a soft market.

Robert Anderson, president of Concord, Massachusetts-based GenRad Inc., is also planning conservatively for 1989 but sees the market growing some: "We are optimistic about board test and see it growing 10% to 20% in 1989. But from the planning standpoint we are keeping it pretty tight." Anderson says that new product introduction is key to GenRad's strategy for this year. "The challenge now is to do product development on an R&D budget that is 13% to 15% of revenue."

Discounts of 10% to 20% are a phenomenon integral to the IC-tester industry

Another factor that is tightening up the test equipment market is the increasing development and use of CAE software. CAE is reducing the number of prototypes necessary in the development of a product, which in turn decreases the need for test. "In the R&D environment you need the same instruments; you just don't need as many of them," says Galen Wampler, president of Prime Data.

The smaller players are still darting about looking for growth in niches. Says William Bean, president of Marconi Instuments Inc., "The low-end tester market is the most underdeveloped part of the market. That is where we are investing our future in the U.S."

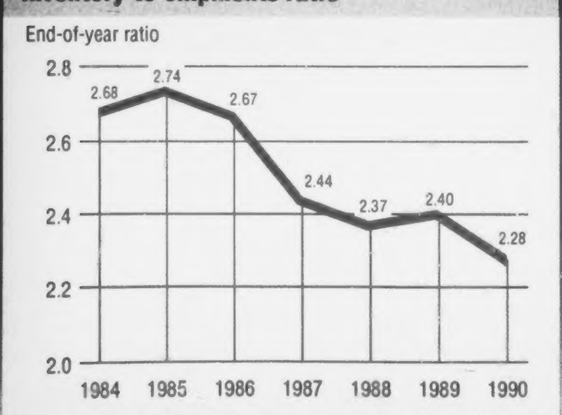
Scope hope

On the instrument side, Bean sees a reasonable growth year — a 10% to 15% uptick — but thinks it is going to be a hard year for instrument makers in general. "The real trick is going to be to find the mini-sectors of the market that are going to do well and get in them," says Bean. Wampler agrees: "We are going to see things slow down in 1989 and come back some in 1990." But he adds that digital oscilloscopes are going to be one of the fastest growing segments of the instrument market, showing 19% growth this year after 30% growth in 1988. Instruments in general look slightly healthier than ATE for 1989, with sales of microprocessor development sytems expected to grow 11.5% and logic analyzer business growing 11.8%, according to Prime Data.

In a year in which revenue growth could be hard to come by, some observers believe that profitability will be a bigger issue than revenue growth. Very few test and measurement companies have shown much return on investment since 1984. ☐

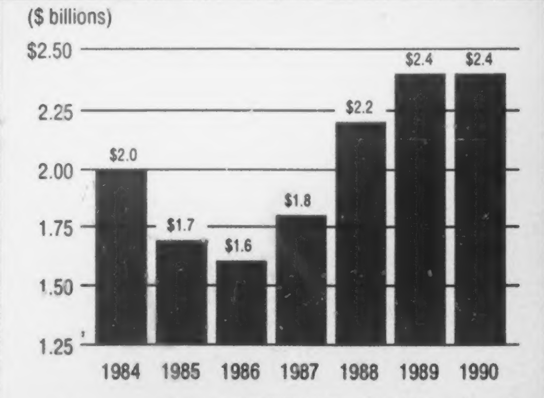
Scientific and engineering instruments

Inventory-to-shipments ratio



Sources: U.S. Commerce Department and Cahners Economics

Worldwide sales of automatic test equipment



Sources: ELECTRONIC BUSINESS and Cahners Economics

Units flat, dollar volume up in TV and stereo sales

U.S. homes are already packed with TVs and VCRs, so unit sales won't thrive. But consumers are still going for big-ticket items

BY PAULA DOE

Consumers won't be spending so freely in 1989. That means flat sales of consumer electronics goods, in units. But some dealers see double-digit growth in dollar volume in TVs and audio equipment, as those buying are choosing pricier products.

Cahners Economics sees meager 0.3% growth in U.S. consumer spending on durable goods in 1989. Inventories are piling up across the economy, bringing cutbacks in factory output, fewer overtime hours and fewer jobs. "People are going to cut back," says Cahners economist Madeline Franchi. "Next year isn't going to be a great year."

"Consumer spending patterns will be flat for 1989," concurs Edward Henderson, president of Henderson Ventures, a market research firm.

Less consumer spending means flat unit sales of major consumer electronics products. Cahners projects a 3% decline in the number of color TVs sold to U.S. dealers. Although sales of VCRs will increase by a meager 1%, total volume will still remain 4% below the 13.3 million units sold in 1987. Some 60% of all U.S. households already have a VCR.

People may not be buying more electronic equipment, but they *are* buying more expensive models. So dealers still expect healthy dollar volume increases in key sectors. When total consumer spending edged up 2.4% in the second quarter of 1988, for example, consumer electronics spending leaped 13.5%, as people continued to buy enhanced TVs, better stereo equipment and camcorders. The Electronic Industries Association notes that 27% of all color TVs sold in the U.S. in 1988 had stereo sound.

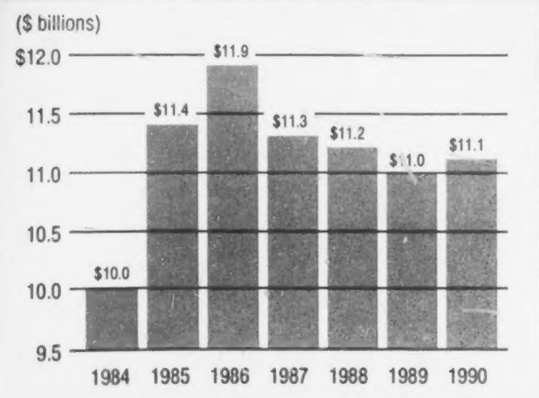
"The good news is really strong numbers in color television," asserts Peter Edwards, president of Video Only Corp., a retail chain. He projects 5% to 10% growth in dollar value of TV sales for 1989, due to increased demand for the pricier large screen and stereo sets. "Enhanced TV will be *the* consumer electronics product of the '90s," Edwards believes.

There's similar optimism over high-end television at Silo Inc., a national electronics retailer. "Although TV sales in units are flat or declining, we expect significant growth in dollar volume over the next three years — into double digits," predicts Roger Salmons, a company VP.

Unfortunately, it's not U.S. producers making these higher value consumer electronics products. Shipments from factories in the United States will slip another 1.5% in 1989, down to $11 billion, according to Cahners' forecast. ☐

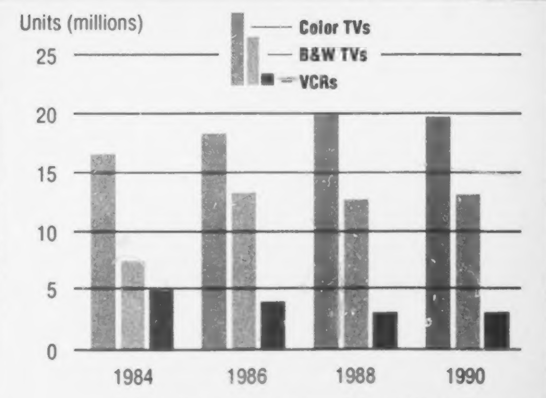
Consumer electronics

U.S. television and radio shipments



Sources: U.S. Commerce Department and Cahners Economics

U.S. sales to dealers



Sources: Electronic Industries Association and Cahners Economics

MILITARY ELECTRONICS OUTLOOK

Real decline forecast for defense

Planning for a slowdown? You should be. Even electronics will come under the knife as the budget cutters go to work

BY BRUCE C.P. RAYNER

Despite the Republican victory last November, there is not much happy talk among defense contractors these days. Peace seems to be breaking out around the world, the U.S. defense budget is shrinking and the industrial base is in need of a fixup. In such a climate, electronics is bound to feel a crunch.

Defense forecasters generally agree that zero or negative real growth will be the norm for the next five years. The Electronics Industry Association (EIA), for example, expects total defense spending to drop from $295.8 billion in fiscal 1988 to a low of $274.9 billion by fiscal year 1994, measured in constant fiscal 1989 dollars. Only in 1995 will the defense budget begin to turn positive and continue to grow at a lackluster pace through the rest of the century.

The slowdown is mirrored in short-term production statistics from Cahners Economics, the economics unit of Cahners Publishing Co. As a result of the budget cutbacks, defense and space production will grow at an annual rate of just 0.1% this year —a slight improvement over the 0.5% decline last year — and then nose dive with a 3.7% contraction next year.

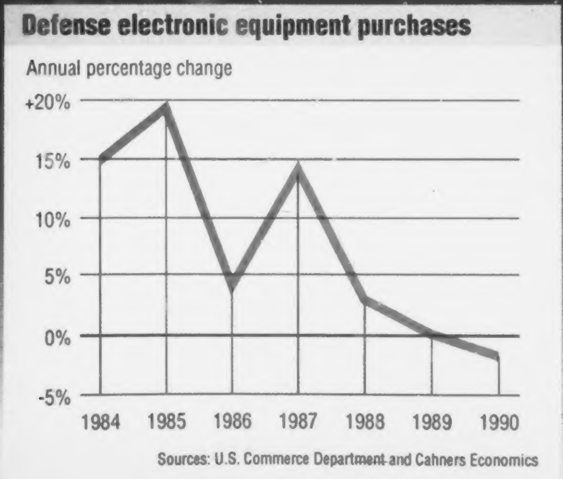
The picture is bleak in electronics too. The overall electronics content of the defense budget is expected to drop from $52.8 billion in 1989 to a low of $51.9 billion by fiscal 1994, the EIA predicts, but will rebound to $54.6 billion by fiscal 1998.

However, the main reason for the slowdown is the urgent need to reduce the federal budget deficit. Sam Nunn, (D-Ga.) chairman of the Senate Armed Services Committee, warns that the defense budget will have to be cut by over $300 billion between now and 1995 if federal budget targets are to be reached.

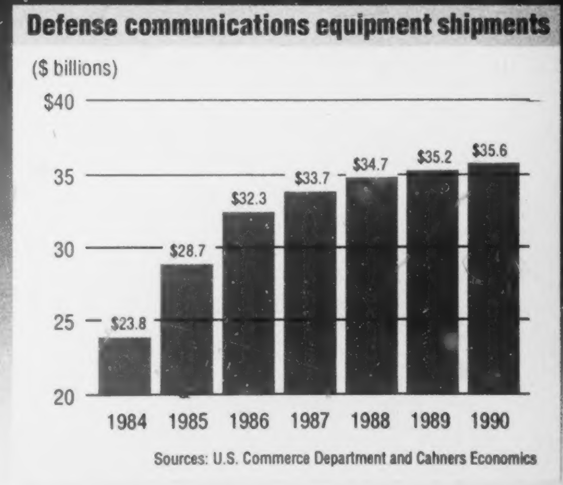
Now for the good news. While there is no silver lining to this cloud, opportunities do exist for forward looking electronics firms. For instance, while the number of platforms — vehicles, aircraft and ships — will decline, industry experts expect the number of retrofits and upgrades to increase. Case in point: enhancements to the B-1B's troubled avionics suite, à la Eaton Corp.'s AIL division, will cost somewhere between $300 million and $3.4 billion between 1990 and 1994, sources say.

One business that shows particular promise is verification. As a result of the Intermediate Nuclear Force (INF) treaty and possibly a Strategic Arms Reduction Talks (START) treaty sometime this decade, on-site verification expertise will be sought. Those experts that designed the missile systems will be needed to help destroy them. ☐

Military


Defense electronic equipment purchases

Sources: U.S. Commerce Department and Cahners Economics


Defense communications equipment shipments

Sources: U.S. Commerce Department and Cahners Economics

India: Struggling to enter the electronics age

The largest democracy in the world has an ambitious high-tech goal: Electronics production of $33 billion by the year 2000

BY BRUCE C.P. RAYNER

From a backward, agrarian-based society held captive by unpredictable monsoons, India is fast becoming an international player in high technology. Electronics production in the world's second most populous nation reached $4.4 billion last year, according to preliminary government estimates, and is expected to grow at around 30% a year for the remainder of the century. But several factors — including the government's insistence on self-reliance, a penchant for bureaucratic meddling and an inadequate industrial infrastructure — could derail the country's ambitious plans.

Nevertheless, India is attracting the keen attention of many multinational electronics companies. For firms in the United States such as Apollo Computer Inc., AT&T, Digital Equipment Corp. and Tektronix Inc., long-term access to the huge domestic market has clearly outweighed the short-term hassles. In telecommunications alone, the Indian government plans to spend $37 billion to implement 16 million more phone lines by the turn of the century. In this, the first of a two-part feature, ELECTRONIC BUSINESS probes India's struggle to enter the electronics age and examines how U.S. firms can best take advantage of the market opportunities there.

Vying for Yankee dollars

For several reasons, India has it over its Pacific Rim and Latin American rivals when it comes to vying for Yankee dollars: English is the unofficial business language there; the country is politically stable; and the labor force is cheap and technically sophisticated. As for the bottom line, profits are easily repatriable and tax holidays are negotiable. The country also provides a gateway to markets in Eastern Europe, Africa and the Middle East.

India's electronics output

($ millions)

	1984	1985	1986	1987	1988*	1989*
Consumer	$221	$394	$691	$856	$1,771	$2,568
Instrumentation/ industrial	168	225	271	352	629	1,394
Computers	52	62	104	188	344	584
Communications/ broadcasting	181	215	255	338	652	945
Defense	100	132	149	201	276	362
Components	154	203	275	342	643	1,409
Software	50	69	57	97	119	262
Total	**$926**	**$1,300**	**$1,802**	**$2,374**	**$4,434**	**$7,524**

* Based on estimates by the DOE and ELECTRONIC BUSINESS
Conversion rate: 14.9 rupees = $1

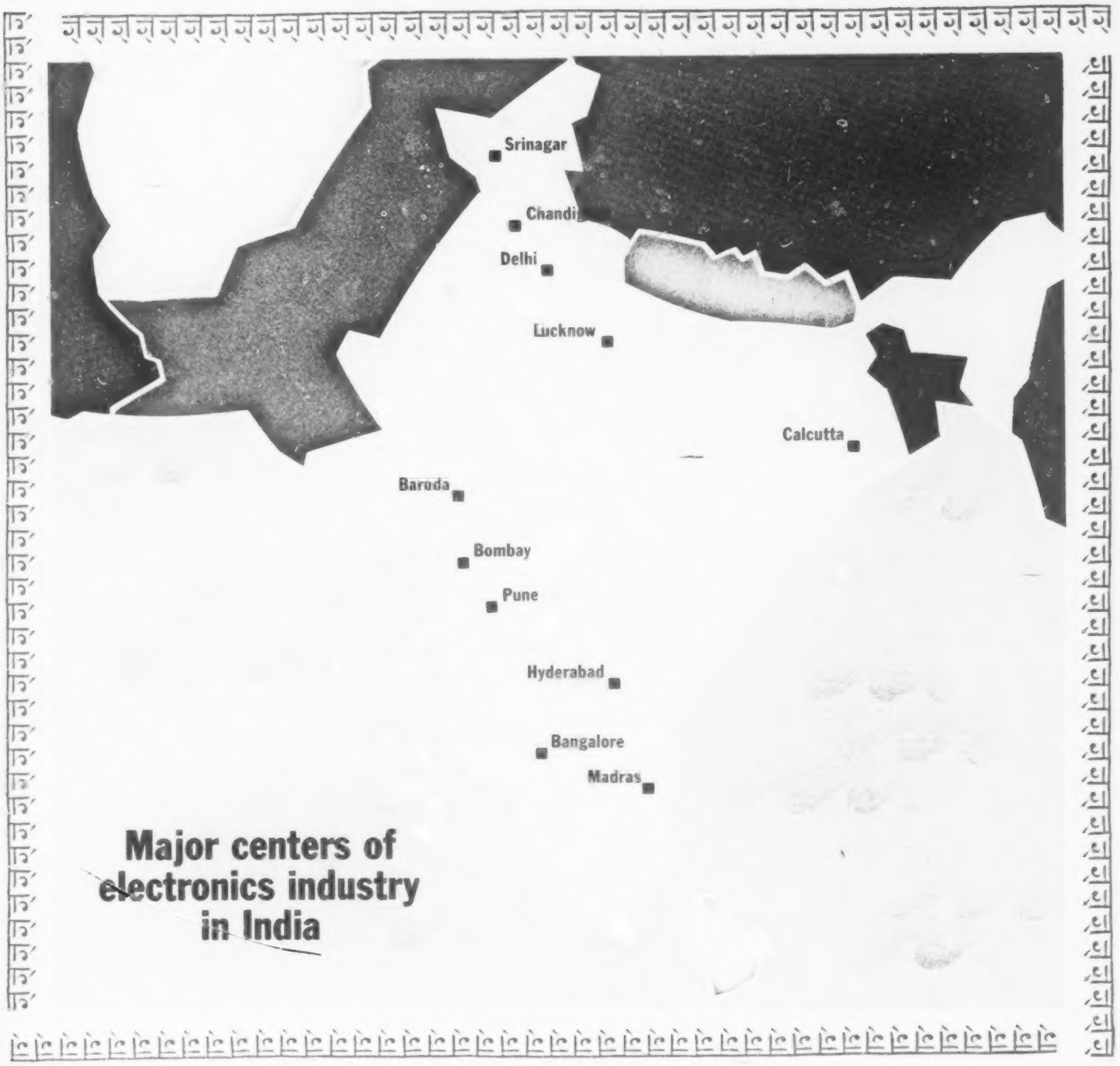
Source: Department of Electronics, Government of India

Direct investments from the West have grown steadily since Prime Minister Rajiv Gandhi came to power in late 1984. As a result, the U.S. pulled ahead of the Soviet Union three years ago as India's top trading partner. In 1987, the U.S. government granted close to 4,000 commercial licenses for the export of high-technology products worth $563 million to India, according to the U.S. Department of State. The figures were up sharply from the 714 licenses, valued at $23.2 million, approved in 1983.

Similarly, the United States led the list of total number of joint ventures, including ones in electronics, formed with Indian companies in 1987. The United States had 196, or 23% of the total, according to the Indo-American Chamber of Commerce. West Germany was second with 149 and Great Britain third with 122.

In total, electronics production in India has grown by nearly three and a half times in the last four years, from about $1.3 billion in 1985 to $4.4 billion last year, the Department of Electronics reports. (The DOE, charged with setting industrial policy, is the government agency responsible for licensing production.) Electronics production is forecast to grow at around 40% to $7.5 billion next year and could hit $33 billion by the turn of the century, according to one optimistic estimate.

But despite India's grand hopes of becoming an electronics powerhouse, several drawbacks exist. Two of India's top priorities are the country's insistence on self-reliance and sovereignty, policies that frustrate foreign investors. Unlike its Pacific Rim neighbors which have opened their arms to foreigners bearing high-tech know-how, India's modernization agenda keeps tight reins on what foreigners can and cannot do in the country.



Major centers of electronics industry in India

Anne Gusman

The biggest constraint is the government's cap on foreign equity ownership. As a result, some foreign companies are hesitant to jump in. Others have withdrawn. IBM pulled out in 1978 after the Indian government forced foreign companies to dilute their equity ownership from 100% to the present 40%. However, rumor has it that Big Blue is currently exploring new opportunities in the country.

India's resolve to determine its own future is understandable. Having gained independence from Britain only 40 years ago, the last thing the country wants is to become the chattel of another Western master. This translates directly into government policy. Imported technology must be transferred to an Indian partner and strict timetables for indigenization of production and local sourcing are painstakingly negotiated.

Running rampant

Government involvement runs rampant. Critics insist the biggest obstacle to growth is *not* access to technology but the many layers of bureaucracy. From the section officer within the DOE to the cabinet minister, there exist 10 levels of government bureaucrats that must sign-off on foreign investments, according to one source. Although the DOE prides itself on its quick turnaround time for joint venture applications — if all goes according to plan, the process takes about three months from start to finish — most collaborations take between 12 and 18 months to get off the ground.

Then there are the cross-governmental approvals. All told, there are six or seven major bureaucracies that foreign investors must deal with on their way to setting up shop in India. These range from getting a production license to being given foreign exchange approval from the Reserve Bank of India.

Over the years, the country's policy makers have controlled production through strict licensing. They have insulated domestic manufacturers — mainly government-controlled public companies — from outside competition, critics contend. Because of the huge unemployment problem in India, the government encouraged indigenous firms to enter markets and set up manufacturing. But the government has not allowed those same firms to exit if and when they become economically untenable. Such coddling has bred inefficiency, and it has also made the status quo fat.

Underneath this bureaucratic morass, lies an inadequate industrial infrastructure. For the foreign electronics company accustomed to Western conveniences, doing business in India is a rude awakening. Electricity brown-outs are commonplace; transportation between states is slow; and long-distance telephone lines are of poor quality. Improvements are underway but, as of now, they've only come in fits and starts. □

[Conversion rate: 14.9 rupees = $1]

Taking the plunge

What you need to know about doing business in India

Foreign firms interested in exploring business opportunities in India have several basic options.

The simplest and cheapest way for you to enter the Indian market is by setting up a liaison office to investigate the local business prospects. This is ostensibly an exploratory venture involving no direct selling. AT&T opted for a liaison office in its first step at marketing into India. (AT&T also has an Indian joint venture with Dutch firm N.V. Philips.)

To sell your product, the common approach, condoned by the government, is to set up a distribution network with an Indian partner. But be forewarned, India's distribution system is unique. In most cases, your Indian partner will not be allowed to stock your product, but must rely instead on his customer to initiate the order process. In this way, a distributor acts more like a consultant or systems integrator than a warehouser.

You should note that although the distribution industry has existed for years in the hardware business, it is a fairly new phenomenon in software. In fact, it was only about two years ago that Microsoft Corp. set up a distribution relationship with Tata Unisys Ltd., a Bombay-based software consulting firm which is a joint venture between Tata Sons Ltd., an Indian conglomerate, and Unisys Corp. Also, Ashton-Tate is gearing up for its debut on the Indian scene.

Besides distribution agreements, another option for foreign investors is the collaborative venture. These come in two flavors: technology transfer and equity participation. Technology transfers usually involve the licensing of products or processes in exchange for a lump-sum payment plus annual royalites. Equity investment agreements are more complex and are recommended only for the seasoned Indophile.

But equity participation is the way to go if managerial control is a priority for you. This is the course that both Tektronix Inc. and Digital Equipment Corp. have taken in their relationships with Bombay-based Hinditron, a leading hardware and software company in India. Similarly, Hewlett-Packard Co. is in negotiations with its distributor, Blue Star Ltd., to set up a manufacturing operation in the near future.

Tektronix had been distributing products in India for over 20 years and, as a follow on, began assembling some low-tech oscilloscopes in one of Hinditron's Bangalore plants about 18 months ago. Based on the success of the line, Tek formed a joint venture with Hinditron late last year and recently took the company public.

"Our intention is to make this a whole company with Indian-based vendors, manufacturing, marketing, training and research and development," states Langdon Hedrick, Tektronix corporate representative in Bangalore. Tektronix has a controlling 40% of the joint venture's shares. The public owns 30% and Hinditron holds the remaining 30%, according to Hedrick.

For DEC, the decision to manufacture in-country was somewhat forced. Because India is trying to expand its own minicomputer industry, it limits imports of those machines. To protect its dominant market share in India — DEC is the No. 1 computer vendor in India and IBM is second — DEC chose to set up a manufacturing operation even though Kenneth Olsen, DEC's chief executive, has said India would be better off importing its machines.

Another business option that the government is pushing hard, particularly in the software area, is the 100% export business that allows 100% foreign ownership. Many of these companies are located in export zones near international airports and can import duty free any hardware they

U.S. high-tech trade with India

($ millions)	1986		1987	
	Exports	**Imports**	**Exports**	**Imports**
Communications equipment and electronic components	$104.2	$11.4	$110.0	$15.9
Aircraft and parts (except engines/turbines)	104.4	0.1	118.2	0.1
Engines/turbines and parts	30.7	3.6	44.9	1.3
Office equipment and computers	86.7	15.1	94.8	4.0
Ordnance	0.05	0.6	0.06	0.5
Instruments	71.2	5.7	82.8	6.7

Source: U.S. Department of Commerce

deem necessary in their operations.

For example, CitiCorp Overseas Software Ltd. has a facility just outside Bombay in the Santacruz Electronics Export Promotion Zone. The company specializes in financial services software and claims sales last year reached nearly $4 million. CitiCorp expects to boost its software business in India by 100% annually for the next few years. □

Getting hitched

Finding the right partner in India is the most important decision you will make

Matchmaking is taken seriously in India. And nowhere is it taken more seriously than in collaborative ventures between foreign and Indian companies. Whether it is distribution or manufacturing, the single most important decision you will make in India is the choice of a partner.

Because of strict limitations on foreign participation, your Indian partner will act as your ears, eyes and voice in any dealings with the myriad government agencies. The better your Indian partner knows the system, the quicker you'll be able to get your products into the market there.

First and foremost, take great pains to ensure that your partner is aboveboard. Petty corruption is rife in India just as in any developing country, so vetting any prospective partners is critical. The litmus test for honesty is a proven track record, say veteran collaborators.

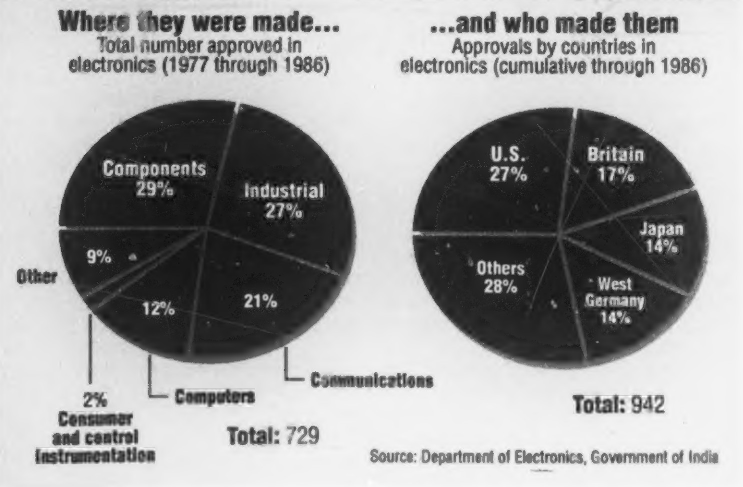
But no matter how much you trust your partner, it is still worthwhile keeping a corporate representative in the country just to watch over the venture's operations. Even though your representative will probably have little legal authority over your Indian partner, a close liaison helps nip potential conflicts in the bud.

There are several agencies that can assist you in background checks. A good starting point is the U.S. Department of Commerce in Washington, D.C., or the Counselor for Commercial Affairs at the U.S. Embassy in New Delhi. Other countries provide the same services at their embassies in the Indian capital.

Two other sources of information are the Indo-U.S. Chamber of Commerce, located in Bombay, and the Confederation of Engineering Industry (CEI), headquartered in New Delhi. Both have offices in Washington, D.C., and the CEI has additional offices in London and Moscow.

For additional matchmaking information, you should also consider the local Non-Resident Indian (NRI) community. They can usually be found wherever high technology flourishes. The NRIs have close ties with government and industry in India and can offer advice on working within the Indian electronics environment. One of the strongest NRI communities is the Silicon Valley Indian Professions Association, based in Santa Clara, Calif. □

India's foreign collaborations



Source: Department of Electronics, Government of India

Keeping the pirates at bay

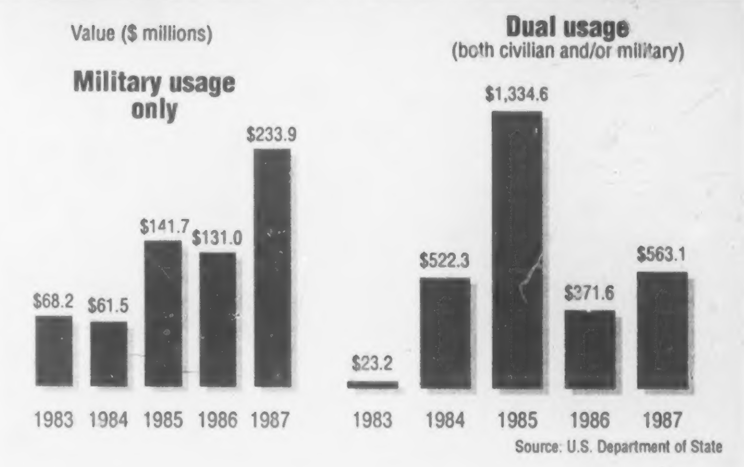
The job of protecting your intellectual property in India is perilous.

Even though India has a tradition of copyright, trademark and patent protection that dates back to the early days of the British Raj, many foreign electronics companies complain that the laws are not adequately enforced. As a consequence, software piracy runs rampant and technology transfers need to be conducted with caution.

"We are a developing country, so we must have the opportunity and freedom to innovate," says K. Nambiar, secretary of the Department of Electronics (DOE), India's government agency that sets industry policy. "At the same time, we are totally respectful of the property rights, acts and patent laws," he adds. Such a double-edged opinion keeps foreigners on their toes.

Outsiders have a more critical view of the country's intellectual property practices. India's copyright protection for software is "dismal," asserts Richard Hevron, Microsoft Corp.'s business development manager for Africa, India and the Middle East. Nonetheless, Microsoft was the first major software company to dive into the Indian market with a distribution deal inked with Tata Unisys Ltd., a large Indian software firm. Like China and Brazil, the Indian market was just too big to ignore, says Hevron. He adds that even though India's

U.S. technology licenses to India



Source: U.S. Department of State

1984 software amendment to the Copyright Act of 1957 is similar to legislation in the developed world, "it does not have any teeth, or we are not being very effective with it."

But that is about to change.The National Association of Service and Software Companies is involved in a media blitz on the evils of software copyright infringement. Sources say Microsoft plans to file suit against one or two of India's worst offenders in an attempt to focus attention on the value of software.

Still, no one is holding his breath as the Indian judicial system is infamous for its protracted proceedings. It may be years before pirates feel the pinch, worry U.S. executives. And even though the government promises to give equal protection under the law, some foreigners question whether this will actually be the case.

Problems exist for chip protection too. India is a participant in the United Nations' World Intellectual Property Organization, which is currently trying to hammer out an internationally acceptable semiconductor protection agreement. The options are either a treaty based on America's 1984 Chip Protection Act or an Indian-recommended codicil to the Berne Convention that would extend copyright protection to chip designs Most likely, WIPO will adopt a variation on the U.S. act, maybe as early as this year.

As for patent protection, India has a 1970 act on the books that is fairly thorough. However, the country is not a member of the Paris Union International Industry Property Convention. Still, any foreigners can theoretically get the same protection under Indian law if they patent their product in the country.

But the best property protection, contends Langdon Hedrick, Tektronix Inc.'s liaison officer in India, is to constantly keep one technological step ahead of the pirates. Tektronix, claims Hedrick, has been doing business in India for over 20 years with such a strategy. ☐

Giving government the slip

Getting the government out of business is far from easy in India. Just ask the country's semiconductor industry

In India, what the government says goes. It's that simple. So when the politicians listen to outsiders, it's worth taking note. In the case of the country's semiconductor industry, it's worth taking a lot of notes.

Last year, 10 highly respected Indian scientists, five from the United States and five from India, made recommendations to the Indian government on how to expand the domestic semiconductor industry. The Joint Scientific Committee, as it was called, suggested India aim for semiconductor production capacity of about $1.5 billion by the year 2000, which would require a total investment of about $3 billion between now and then.

The innovative idea was that only 20% of that investment should come from the government, with the rest coming equally from Indian and foreign private concerns, says committee member Krishna Saraswat, professor of electrical engineering at Stanford University. The idea was that the proposed $2.4 billion in private investment would be motivation enough to insure efficiency and the $1.2 billion in foreign investment would insure leading-edge technology, reasoned the industry gurus.

Elements of the committee's proposals are indeed being adopted. For example, per the committee's recommendation, 10 design centers for application-specific integrated circuits are being set up around the country. But the government will be loathe to relinquish total control over the chip industry, critics contend. Still, even if the recommendations are only half-heartedly embraced, the committee's framework still sets the tone for the future: more open competition, less government control and more international involvement.

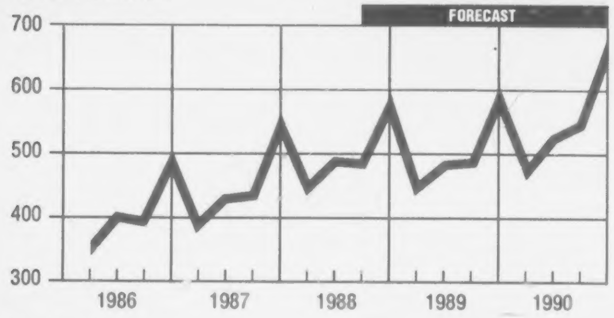
As a direct outcome of the committee's recommendations, Saraswat says, VLSI Technology Inc. of San Jose recently signed a technology transfer with Indian Telephone Industries Ltd. (ITI) to produce 1.5-micron very large scale integrated chips at ITI's fab in Pune.

"We see India as a huge opportunity," declares Cliff Roe, director of Strategic Programs at VLSI Technology, "but they definitely have a different way of doing business." Barriers include currency controls and a sluggish bureaucracy, he complains. But with help from the Joint Scientific Committee, some of those barriers are being whittled away. ☐

ELECTRONIC BUSINESS indexes

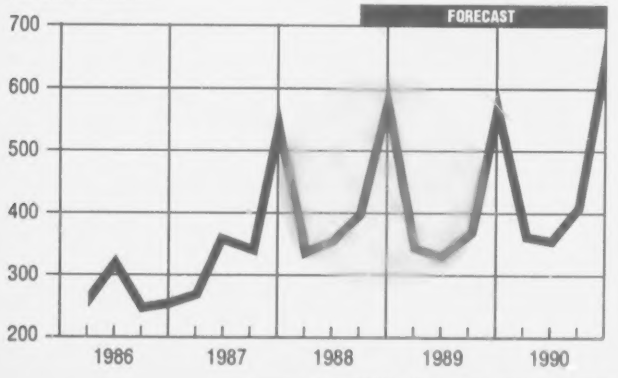
Revenue index

1st quarter 1975 = 100



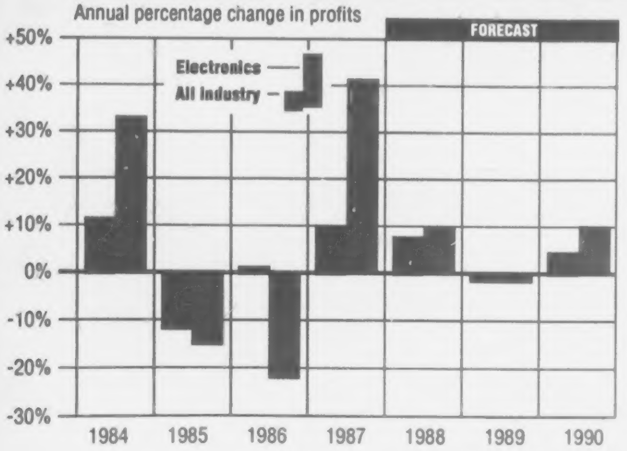
Profits index

1st quarter 1975 = 100



Sources: ELECTRONIC BUSINESS and Cahners Economics

Profit growth: Electronics versus all industry



Sources: U.S. Commerce Department and ELECTRONIC BUSINESS

Profit forecast: 1989 will not be a rerun of 1985

Recent evidence indicates that 1989 will be no 1985. Example: revenue grew 10.6% in the third quarter of 1988, compared with a year earlier for the 16 electronics companies included in the ELECTRONIC BUSINESS index. That's down from 14.9% growth in the first quarter, but still healthy. Profits grew 15% in the third quarter.

Revenue growth by the top U.S. electronics makers has accelerated well into 1988, but that growth will be slowing down in 1989. And profits, after picking up 41% in 1987 and an estimated 9% in 1988, will most likely drop again this year, the first decline since the gloomy years of 1985 and 1986.

These forecasts won't make Wall Street happy, but industry executives will find the 1989 perspective easy to live with. Why? Because the profit picture will not be a rerun of the 1985 horror classic.

Profits at electronics companies tumbled 17% in 1985 and again down 24% in 1986. While electronics profits plummeted, all industy after-tax profit dropped only 13% in 1985 and managed to inch up 2% in 1986. That was the first time since ELECTRONIC BUSINESS began tracking industry profits in 1975 that electronics fared worse than the rest of the economy.

Over the next couple of years, the electronics profit forecast will mirror profit gains in the entire U.S. industrial market. In fact, in 1990, if the economy can stave off a recession, electronics profits will again be outracing the rest of industry.

What's changed between 1985 and 1989? First of all, everyone these days looks at inventory far more carefully. Gone are the days of double- and triple-ordering and subsequent serious inventory overhang, at least for the next 365 days. With inventory management doing its job, other management tasks have also been planned much more cautiously. Operating costs are being held down and export markets are being promoted — all like never before.

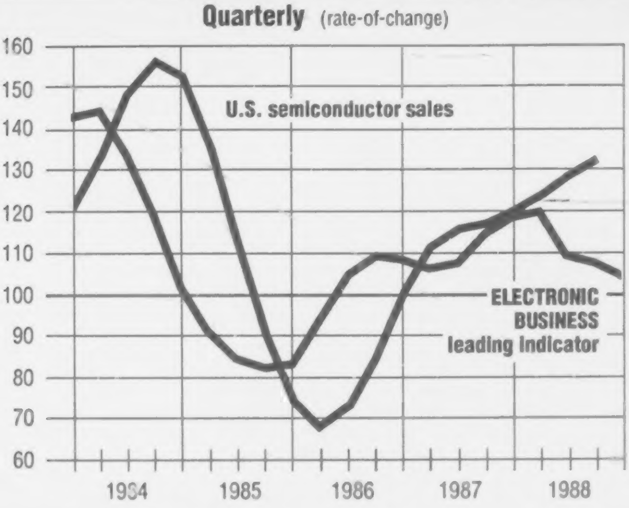
Don't underestimate the impact of those juicy export markets. As long as the value of the dollar doesn't take an unexpected turn upward, made-in-the-USA computers, instruments and other electronic products will be easier to sell at lower prices abroad. In fact, of the companies ELECTRONIC BUSINESS tracks, those with the largest shares of foreign revenue fared the best in 1988 and should do so again this year.

ELIZABETH B. BAATZ

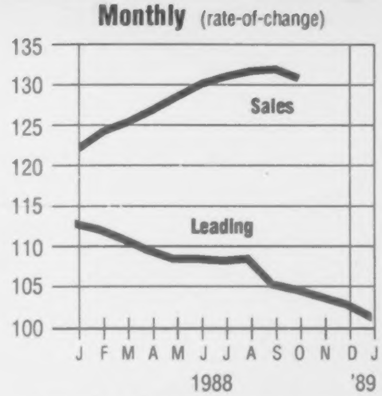
BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368



The ELECTRONIC BUSINESS leading indicator continues to inch downward. From a peak of 120 set in October 1987 the indicator has fallen only 19 points by January. Compare that with the 1984 experience. Fifteen months after the January 1984 peak, the indicator had lost 60 points. Clearly, the 1989 slowdown will be far different, and easier than 1985.

Source: Cahners Economics

Electronics industry indicators this month

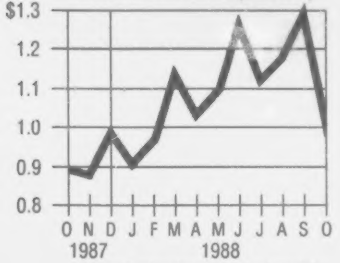
	Latest month	Previous month	Year ago	1987 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Sept.)	105.6	108.8	117.7	111.1
U.S. semiconductor bookings ($ millions, 3-month average, Oct.)	$1,064	$1,166	$1,006	$951
Weekly hours of semiconductor production workers (monthly average, Sept.)	40.2	40.1	40.2	40.6
Electronic components leadtime index (1977 = 100, Nov.)	99.8	109.7	96.7	100.7
S&P's semiconductor stock price index (1970 =10, monthly average, Oct.)	48.1	51.0	68.5	65.5
Change in electronic components inventories ($ millions, SA, Sept.)	+$72	+$115	+$71	+$41
Contract and orders for plant and equipment ($ billions, SA, Sept.)	$38.4	$43.7	$34.5	$34.6

SA = seasonally adjusted, all other data is not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

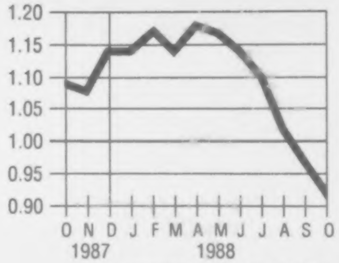
Semiconductor sales

North American market ($ billions)



Source: Semiconductor Industry Association

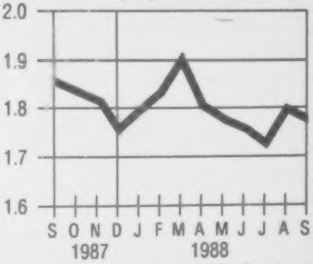
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted ratio



Source: U.S. Commerce Department

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

JANUARY 23, 1989

THE BIG CHILL

How Japan's strategy may freeze the U.S. out of the superconductivity game PAGE 24

an's expanding solar system PAGE 46

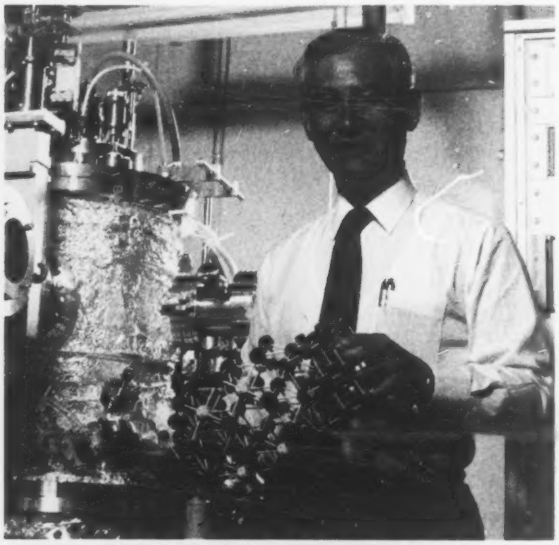
dia's iron-fist invitation PAGE

Fujio Saito,
NEC Corp. vice president

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 15, NO. 2 **JANUARY 23, 1989**



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There is less and less question that Japan is ahead in superconductivity. The Japanese are outrunning the U.S. in terms of technology gains, applications focus and resource allocation. While most of the world focuses exclusively on high-temperature superconducting materials developed over the past two years, the Japanese are covering all possible bases in their superconductivity research. And, with a technology that could revolutionize a number of electronics fields at stake, might American companies be caught sitting on the sidelines?

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INSIDE BUSINESS

U.S. out in the cold?

Superconductivity is the next great frontier for electronics companies. Not surprisingly, therefore, scientists around the world are racing to develop applications and get to market first. And the Japanese appear to be winning. "All the indications are that Japanese resolve in superconductivity is outrunning that of the U.S.," says the Council on Superconductivity for American Competitiveness.

Indeed, the Japanese are poised to freeze out their competitors — in applications, though, not necessarily in research. Because while most of the world focuses on recently developed high-temperature superconductors — ones that, it is hoped, will work at room temperatures — the Japanese are also targeting well established low-temperature materials and processes.

Japanese officials figure that once the high-temperature ceramics come on stream, it will be easy to replace the old materials with the new ones. Meanwhile, they reason that by continuing to develop the established cool products, they can focus on shorter-term applications rather than pure research. ELECTRONIC BUSINESS sent David Gumpert, editor and publisher of "The Cambridge Report on Superconductivity," on special assignment to Japan for a look at superconductor research there. In this issue's cover story, he analyzes the race and projects the winners.

Sun's solar system

Since Sun Microsystems Inc. first rose in the sky, hundreds of VARs, OEMs, suppliers and partners have swung into synchronous orbit. Business — for both the workstation maker and its satellites — has been good. But are there risks? Associate editor Rick Whiting details the star-studded galaxy of Sun followers and wonders if, like Icarus, whose wings melted when he flew too close to the sun, third-party companies may get burned by getting too close to this newly created Sun.

Assistant editor Tony Greene

Meet Tony Greene

Although many of you manufacturing readers have already fielded his piercing interviews over the phone, our assistant editor Tony Greene hasn't quite met all of you in his half-year here. The thousands he met at Autofact and ITC know what he looks like; for the rest of you, that's him in the picture. In this issue, Tony explores two topics: the difficulty incurred in testing ASIC products and the increasing importance of high style in computer design.

BETH KARLIN, managing editor

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Media makers escape the disk drive fallout

Makers of disk platters switched early to hot growth products. But now they may be building problems of their own

Despite the difficulties some of their major customers have been having lately, most disk media executives can be seen sitting at their desks wearing generous smiles. With laggard sales of conventional disk drives staring them in the face, they knew it could have been worse.

Indeed, that's the way it seemed. When disk-media supplier Xidex Corp., the major supplier of rigid-oxide platters to Seagate Technology, closed its Irvine, Calif., plant, it laid off over 800 employees and followed that with pink slips for another 395 at its Santa Clara facility. At first glance, it looked as if Seagate's high-visibility troubles had prompted the shutdown.

Additionally, stocks of disk-media firms plunged in synch with Seagate's slide on Wall Street. And late last year, several media makers found themselves working overtime to get paid by some cash-strapped drive makers. All this for an industry that is stretching its capital to build more manufacturing plants both at home and abroad — an industry whose process technology and capital-equipment needs have more in common with chip makers than with disk-drive builders.

Despite a slight overall decline in disk-platter orders in the second half of 1988, media manufacturers have fared pretty well. Most are showing enough savvy to shift away from no-growth 5.25-inch disks and are concentrating more on better-selling 3.5-inch media. According to the Santa Clara Consulting Group, a market researcher that tracks the disk-media industry, media makers this year will ship almost as many 3.5-inch platters as 5.25-inch types — 27.6 million versus 29.5 million. Two years ago, the ratio was almost 2.5-to-1 in favor of shipments of the larger units; by 1992, it will be almost 1-to-2.

This switchover mirrors the move toward the smaller drives. Researcher Disk/Trend Inc. reports that this year, for the first time, drive makers will ship more 3.5-inch units than 5.25-inch models — 7.8 million units, compared with 4.8 million.

Consequently, most media suppliers are predicting solid growth by as much as 50% this year; one firm, Komag Inc., expects to finish the year with sales of up to $90 million, twice its 1987 levels. For the market as a whole, the Santa Clara Consulting Group predicts growth from $600 million in 1988 to $1 billion by 1992 in worldwide 3.5- and 5.25 -inch disk platters.

Growing like weeds

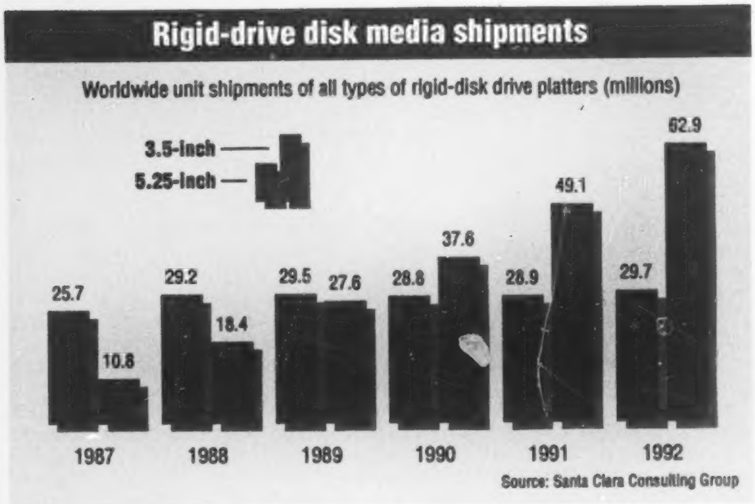
Manufacturers report that thin-film media products remain very much in demand, albeit less than was expected prior to Seagate's stunning announcement that it had lost $52.8 million during its September quarter. "[Media] unit volumes are growing like weeds," says analyst David Vellante, director of storage research for International Data Corp. In 1988, over 18 million thin-film disks were manufactured worldwide for the merchant market, twice the number manufactured in 1987, according to Dave Pearce, president and CEO of Domain Technology Inc.

Domain, second only to Seagate in thin-film media production, made 1.8 million platters during its September quarter, up 17% from the previous quarter. Pearce expects to show a modest increase in the December quarter, to about 2 million, a slowdown from the 2.2 million expected.

What's buffering media makers from feeling a greater impact of the sagging sales of a few drive makers is a shift in the industry's product mix. Demand is up for 3.5-inch disks and down for 5.25-inch disks, a tran-

Komag marketing vice president Hunt Payne: "Our business will return to being only good"

Cindy Charles


Rigid-drive disk media shipments

Worldwide unit shipments of all types of rigid-disk drive platters (millions)

Source: Santa Clara Consulting Group

sition that gives component vendors a broader customer base and offsets the overall decline in orders. "The imbalance in supply and demand is less noticeable with components makers," says Komag's vice president for sales and marketing, Hunt Payne. "Media people are pretty close to being in balance."

However, problems hounding the disk drive industry have touched, if not troubled, the media sector. Last November, Komag suspended shipments of sputtered thin-film disks to MiniScribe Corp. for two weeks because the drive maker was late paying for materials. Domain also reported late payments from the Longmont, Colo., drive maker. Komag had similar problems with Micropolis Corp. of Chatsworth, Calif.

Industry observers cite as a normal phenomenon the stretch in credit periods toward 90 days, from the generally acceptable 30 to 45 days, when the drive makers are hurting for cash.

More alarming were the shivers sent through the industry last summer when giant Seagate, which still makes 34% of the world's disk drives, slashed production by a third after borrowing $290 million to expand its manufacturing facilities. Seagate later laid off more than 1,000 employees, nearly 25% of its national workforce. As a result of Seagate's misforecasting of demand, drive manufacturers are now seeing price-cutting efforts by the company to eliminate the $318 million worth of inventory that industry analysts say it still had at the end of the year.

However, other drive manufacturers also reported disappointing sales during the second half of 1988, which translated into slower orders for media manufacturers. Maxtor Corp. reported a slight decline in its net earnings at the end of September, down to $1.1 million, compared with the $2.0 million profit posted in the previous quarter. Micropolis declared a more substantial net loss of $12.6 million at the end of September.

The problems brought precipitation in financial circles: Domain reports that its stock was trading at $8.50 last August, but fell to a low of $4.50, a $30 million drop in value, at the time Seagate's bad September quarter went public. "Even though we reported a strong quarter, we were guilty by association," says Pearce.

Most media suppliers are predicting as much as 50% growth this year

And while Seagate probably was not solely to blame for the Xidex plant closures — insiders say the shift from oxide to higher information density thin-film media would eventually have caused the plant to close anyway — the view is that the closure was accelerated by Seagate's troubles.

Other media suppliers have fared much better. "We've seen a slowdown in our business because of inventory corrections in the disk drive industry," says Domain's Pearce. Other media companies report similar downturns, but all remain highly optimistic that they will enjoy a steady growth rate into the 1990s.

Even though new orders have not met the expectations of the media manufacturers, companies are quick to note business is much stronger than it was in 1987. "We think our growth rate will be reduced in 1989; it will return to being only good," says Komag's Payne.

To help fuel that strong growth, media makers are pulling out all the stops to build new facilities. Domain has completed a new $10 million manufacturing plant in Milpitas, Calif., due to be on-line in April. Financed through equity loans, the new high-speed sputtering system will give Domain a production capacity of 1 million disks per month.

In addition, Domain is also increasing manufacturing in its Singapore facility, while Komag is eyeing the country as a possible site for its first overseas factory. Komag is also investing about $30 million in a new plant in San Jose, due to open later this year. The new factory, with a capacity of over 500,000 disks a month, is being financed through a combination of sources including $28 million remaining from the company's IPO in May 1987.

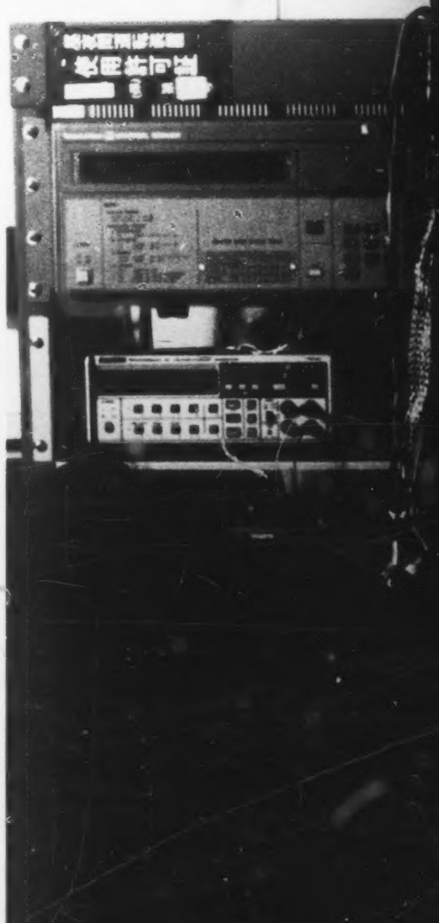
But analysts warn that new production facilities could set the stage for an intensive price war as a result of factory overcapacity. "Our impression is we're going to be up to our knees in thin-film media by the end of the year," according to Phil Devin, an industry analyst for Dataquest Inc. If companies expand as planned, worldwide capacity could go as high as 100 million units by the end of 1989, according to Mark Geenen, industry analyst at Santa Clara Consulting Group. In addition to that, if demand estimates of 50 million units in 1989 ring true, capacity for their film disk platters will be two times higher than demand, according to Geenen. If that should happen, a price war is the logical result, and smaller media companies would be hit the hardest, according to some analysts.

JOHN MCCREADIE

Japan's allocations of money and manpower to superconductivity research could freeze the U.S. out of the race for applications

The Big chill

BY DAVID E. GUMPERT



Fujio Saito, an NEC vice president: Over the next few years, NEC execs hope a superconducting chip will become the basis for an NEC supercomputer

Eig Miyazawa/Black Star

In a small lab in NEC Corp.'s central research facility on the outskirts of Tokyo, Hitoshi Igarashi, a senior research manager, is showing off a superconducting thin-film device. The film, composed of a ceramic — one of the recently emerged family of materials that superconducts at 120° Kelvin (−153° C) — is only 0.03 microns thick and is nearly imperceptible. "It is so thin, it looks transparent," Igarashi marvels.

The thin-film-based device is the forerunner of a superconducting computer chip or measurement device. Unfortunately, it's the forerunner by three or more years of a commercially useful device. "Much work remains to be done," admits Fujio Saito, an NEC vice president.

But NEC officials aren't at all concerned about the lengthy time horizon. Because, down the hall sits another lab, in the corner of which is a clear plastic box nearly filled with tiny chip-like devices. Unlike ordinary chips, though, these use niobium titanate on an aluminum-oxide base. At liquid helium temperatures approaching absolute zero, each chip employs a Josephson junction superconducting transmission device to become the basis of a computer with 1 kilobit of random-access memory.

These chips are the result of 10 years' work at NEC using the long-existing low-temperature superconducting technology. Over the next year or two, it will get its own packaging, architecture, and cooling system and become a complete large-scale integrated circuit. At that stage, it will be a strong candidate to be the basis of an NEC supercomputer.

The NEC research approach illustrates an important reason for Japan's emergence as the world's leader in superconductivity. As evidenced at the International Superconductor Applications Convention two weeks ago in San Francisco, most of the rest of the world focuses exclusively on the materials developed over the past two years — the copper oxides commonly referred to as high-temperature superconductors. But the Japanese are covering all possible bases by also targeting well-established low-temperature superconductivity.

Hedging bets

This hedging of bets will likely enable the Japanese to be first with superconductor-based products in the electronics marketplace, and that's important because electronics products will probably be the first to put commercial volume behind superconductivity. In addition, the Japanese are concentrating on transportation and power transmission applications.

There is less and less question that Japan *is* ahead — in terms of technology gains, applications focus and resource allocation. "All the indications are that Japanese resolve in superconductivity is outrunning that of the U.S.," says a recent progress report on policy analysis from the Council on Superconductivity for American Competitiveness, (CSAC) a Washington, D.C.-based trade group of U.S. companies involved in superconductivity developments. "Our industrial competitors will inexorably ensure that the window of opportunity will not remain open forever," chides the report.

The CSAC argues that the federal government has not adopted any kind of active overall policy, despite introduction of an 11-point recommendations plan by the Reagan administration in July 1987. Instead, says the group, many of those 11 points have barely been winked at: while some federal monies have been redirected from other R&D programs to superconductivity research, and patent approvals have been sped up, antitrust rulings on joint R&D ventures have not been relaxed and top policy-making roles have been slow to be designated.

In a step toward a federal policy, however, President Reagan signed legislation last November to establish a program to speed superconductivity R&D. The legislation requires that the Office of Science and Technology Policy establish a five-year plan for R&D in the field. Although published reports say the government has stepped up total funding on superconductivity — from $84.6 million in fiscal 1987 to more than $147.5 million in the current fiscal year — the plan recommends new funding and includes proposals for private sector and academic participation in R&D projects.

Why worry?

But why should U.S. electronics executives worry?

It might be easy to rationalize the Japanese lead in superconductivity as "just one more area" in which the United States is failing to compete aggressively. Unfortunately, superconductivity isn't "just one more area." Supremacy in superconductivity may well mean supremacy in many aspects of electronics, ranging from computers to sensors to miniature antennas to millimeter waves.

The disk drive maker with the first frictionless spindle bearings courtesy of superconducting materials stands the best chance of reducing data seek and access times to unheard-of levels. The computer maker that first employs superconductive wire in board-level interconnects can boast blazing operating speeds. And semiconductor firms surely have a strategic stake in experimental superconductive 4-bit microprocessors that have been clocked at 770 MHz.

Because superconductivity confers so many advantages in terms of speed, energy consumption, size and other factors, it could quickly revolutionize a number of electronics fields. What is now required — and what U.S. firms could collaborate on —is for a number of technical and fabricating problems to be solved and for the economic advantages of using superconducting technology to be proven.

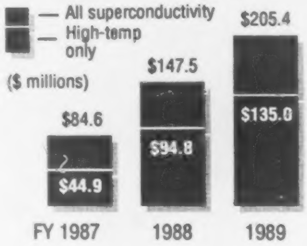
In the truest American tradition, numerous start-ups have set off to commercialize superconductivity developments — companies like

Superconductivity's share of U.S. government R&D spending

Total R&D spending ($ billions)

FY 1987	1988	1989
$55.255	$58.152	$60.323

Superconductivity R&D spending



Figures include military research

Source: U.S. government report: "Federal Research Programs in Superconductivity"

The paper chase: Japan's patent blitz

Japanese companies and government agencies are leaving no stone unturned in their effort to control the emerging superconductivity industry.

The most recent evidence for this view comes from European patent offices. In Britain and West Germany, patent applications are made public 18 months after filing; in the U.S., applications are secret until patents are awarded, which can be two or three years after filing.

Because many of the initial patent applications were filed in January 1987, when the first high-temperature superconducting materials were being developed, the public is getting its first glimpse into the proprietary side of superconductivity. Of 75 superconductivity patent applications examined by "The Cambridge Report on Superconductivity" that had been made public in Britain and West Germany, the scorecard as to country of origin shows that Japan fielded 59 to the United States' 10.

Of the 59 Japanese patent applications, more than half come from three companies: Sumitomo Electric Industries, Mitsubishi Heavy Industries Ltd. and Hitachi Ltd.

Among the American patent applications are some very significant ones, including two for the original yttrium-barium-copper oxide compound that started the superconductivity gold rush — one for the University of Houston on behalf of researcher Paul Chu and one from IBM on behalf of pioneering scientists Georg Bednorz and Alex Müller. The other American patent applications come from such companies as General Electric Co. and General Dynamics Corp., along with government agencies such as the Department of Energy and the Defense Department.

The most significant of the applications appear to relate to superconducting wire and transistors. For instance, several of the Sumitomo applications cover high-temperature superconducting wire made by packing and drawing 1-2-3 material in a metal pipe. Both NEC and Hitachi have applications for transistor-type devices. ☐

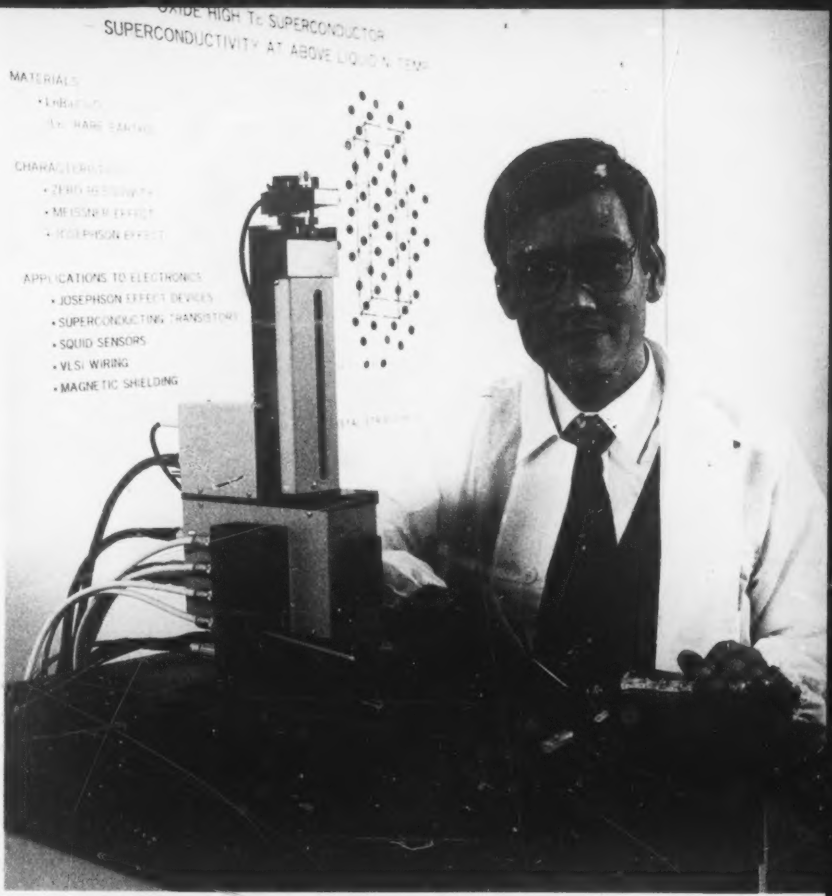
American Superconductor Corp. of Cambridge, Mass., Superconductive Components Inc., of Columbus, Ohio, and Superconductor Technologies Inc., of Santa Barbara, Calif. But there are doubts that these newcomers have the critical mass and critical funds to push the frontiers far enough, and concern that the U.S. companies that do have the resources are sitting on the sidelines, monitoring international activity. The feeling at many U.S. companies is that once the technology is further along, they'll plunge in and quickly play catch-up. "If things really break, we'll commit to it," is typical of the defense put up.

Body of knowledge

Unfortunately, that may not be possible. As with a number of very complex technologies, superconductivity requires a body of knowledge that can't be picked up on the run. The high-temperature superconducting materials are ceramic oxides that are extremely difficult to fabricate, as researchers around the world, including those in Japan, are rapidly discovering. Because of the difficulties associated with turning the materials into commercial products, all companies involved in superconductivity have lengthened their time horizons some, seeing more applications occurring within five to 10 years rather than two to five years, as some had hoped.

Japan's applications push has plenty of justification. "The Japanese are right in presuming that everything we need for applications is already out there," says Richard Rhodenizer, manager of General Electric Co.'s superconductor applications program in Schenectady, N.Y., who recently toured Japanese superconductivity facilities. "I don't think the technology depends on high-temperature superconductivity, except for certain areas of electronics."

GE is active in both the low- and high-temperature research areas. It has been able to establish a dominant position in the major commercial application for superconductivity until now — magnetic resonance imaging (MRI) equipment used for medical diagnostics. Researchers estimate that GE has up to 50% or more of the world's nearly $1 billion MRI equipment market. Toshiba Corp. has just begun marketing its own line of MRI machines.


XIDE HIGH Tc SUPERCONDUCTOR
SUPERCONDUCTIVITY AT ABOVE LIQUID N2 TEMP
MATERIALS
CHARACTERISTICS
• MEISSNER EFFECT
APPLICATIONS TO ELECTRONICS
• JOSEPHSON EFFECT DEVICES
• SUPERCONDUCTING TRANSISTORS
• SQUID SENSORS
• VLSI WIRING
• MAGNETIC SHIELDING

Hitoshi Igarashi, NEC senior research manager: "Much work remains to be done" in superconductivity

Given the paucity of applications for either low- or high-temperature superconductivity, how can one be so sure that the Japanese are ahead? By comparing the American and Japanese efforts on three levels, including technical advances, resource commitment and planned applications. This comparison is based on extensive conversations with American and Japanese officials involved in superconductivity, as well as a recent tour of Japanese superconductivity facilities.

Technical advances. The major challenge associated with making superconductivity widely applicable in electronics is in fabricating the high-temperature materials, which are essentially ceramics, so that they can be easily produced. They also must be able to carry currents necessary for common applications. In the area of wire for motors, the minimum acceptable current-carrying capacity is thought to be 10,000 amperes per square centimeter (A/sq. cm.) in a high-magnetic field. For thin films, the capacity must be significantly higher.

One American company — AT&T — exceeded that figure months ago in 1cm. pieces that handled 17,000 A/sq. cm. In a one-tesla field, though, current goes down to 4,000 A/sq. cm. Other American companies are struggling to get beyond a few hundred A/sq. cm. A handful of Japanese companies are rapidly approaching the 10,000 A/sq. cm. figure with and without magnetic fields, and are confident of going far beyond it very shortly.

One of the most successful Japanese companies involved in making such wire appears to be Hitachi Ltd. The company has achieved critical currents of 6,700 A/sq. cm. in a superconducting copper oxide, based on thallium, and expects the number to keep rising. "We are going to develop thallium wire that is more than 10,000 A/sq. cm." by early 1989, says Toshimi Matsumoto, senior researcher in Hitachi's Tokyo research lab.

That current will be achieved without the presence of a magnetic field, but, based on preliminary work, Matsumoto is confident that Hitachi will quickly raise currents with the introduction of magnetic fields.

Hitachi uses a drawing, rolling method to make its wire, reducing its

Hiroyuki Abe, NEC research manager: NEC has spent 10 years researching low-temperature superconducting technology

diameter from 6mm to 2.8mm and its thickness from 0.5mm to 0.06mm in a tape-shaped wire that is as yet not flexible. The brittleness of today's superconducting materials is one barrier to commercialization.

Another Japanese company, Mitsubishi Heavy Industries Ltd., says it has developed an approach for processing bismuth-based high-temperature superconducting materials into filaments, 1,000 of which can be used to fabricate multicore wires. While the current capacity of the multicore wire hasn't yet been determined, each filament has a current density of as much as 1,100 A/sq. cm.

Sumitomo's successes

In the area of thin films using high-temperature superconducting materals, American companies have been extremely reluctant to disclose their technical advances. But at least one Japanese company has been more forthcoming. Sumitomo Electric says it has achieved 3.5 million A/sq. cm. using a high-temperature superconducting material.

Resource commitment. At first glance, it appears that the United States and Japan are devoting nearly the same resources to superconductivity supremacy — somewhat more than $200 million each in government and industry spending, according to a lengthy study from the Congressional Office of Technology Assessment (OTA) issued last year. But behind that figure are some important differences.

One has to do with the level of resources Japanese companies are committing to the development effort, versus American companies. The National Science Foundation's Tokyo office surveyed 38 Japanese companies significantly involved in superconductivity and found that they expected to spend $90 million in 1988 on such R&D. These companies have about 900 scientists and technicians at work on superconductivity. Significantly, this survey didn't include at least 21 other Japanese companies known to be heavily involved ~~in~~ superconductivity research; their inclusion would have raised the spending and manpower figures significantly.

Those 21 — like the other 20-odd members of International Superconductivity Technology Center, a consortium backed by Japan's Ministry of International Trade and Industry, must each put up over $800,000 to join.

On the other hand, an exhaustive survey of American companies in superconductivity conducted by the OTA found 55 American companies spending about $97 million and involving about 625 scientists and technicians at work on superconductivity R&D in 1988. Clearly, the resource commitment is less than that in Japan.

A comparison of individual companies indicates the scope of the differences. An official of Sumitomo Electric, one of Japan's most aggressive companies in superconductivity, says that company has more than 80 researchers and technicians involved in developing the technology. A more typical effort, such as that at NEC, involves between 30 and 40 people. In the United States, by contrast, the largest efforts, such as those at AT&T and E.I. du Pont de Nemours & Co., are understood to involve up to 40 people each.

The OTA concluded in its report, issued last June: "The Japanese have committed funds, not only to research, but to evaluate prospective applications. Executives there see [high-temperature superconductivity] as a vehicle for creating new businesses, while Americans are more likely to view it in terms of existing lines of business."

Greenhouse effect

Why are the Japanese more willing than American companies to commit resources to superconductivity? The answer seems to lie in their larger view of the world and their expectation that, even if they can't justify superconductivity in today's cost and market analyses, they will be able to justify it in the future. They are betting that such trends as the depletion of energy supplies, the "greenhouse effect," and growing demand for electricity will combine to make superconductivity increasingly attractive in the future. As the OTA report put it, "The Japanese seem confident that investments now will pay off — some time and in some way."

Moreover, the Japanese obsession with superconductivity is creating competitive pressures among companies to commit substantially to this new field. "The main reason we are doing research in superconductivity is because so many other Japanese companies are working in it," according to a remarkably candid Nobuo Hashizume, a deputy general manager at Sharp Corp.'s central research laboratories.

Applications focus. As noted earlier, Japanese corporations are so concerned with developing applications that they are committing substantial resources to low-temperature superconductivity, which doesn't have the fabrication/critical-current problems of high-temperature materials. In Tsukuba, just north of Tokyo, 60 researchers at the Electrotechnical Laboratory, Japan's national lab and its foremost electronics research organization, are at work trying to perfect applications for low-temperature superconductivity and to further develop the high-temperature materials.

One of its applications efforts involves using superconducting quantum interference devices (SQUIDs) to help detect heart and neurological abnormalities. In a laboratory, researchers test out a SQUID integrated onto an 8mm by 8mm silicon chip by testing it on subjects placed into a 6-feet by 6-feet square magnetically shielded vault which eliminates background "noise."

While this SQUID system isn't yet ready for commercial production, it is making progress. According to one American expert who examined it, "It makes the EKG look like a crude instrument."

Japanese researchers working on high-temperature materials also have a decided applications focus. Sharp is trying to use the high-temperature materials to develop galvano magnetic devices that detect slight changes in magnetic field.

If such devices can be made using high-temperature superconductors, their sensitivity could be increased several orders of magnitude over conventional devices, says Nobuo Hashizume, the deputy general manager of Sharp's central research laboratory. While conventional galvano magnetic devices are sensitive at 10^{-3} gauss, Sharp's high-temperature superconducting devices have already slightly beat that sensitivity. "The drawback is that we have to go to 77° Kelvin," which is the temperature of liquid nitrogen, to achieve superconductivity, says Hashizume.

To make it competitive, then, requires that it be significantly more sensitive than conventional devices, he says. "Our first goal is to increase

1,001 uses for superconductors

It's been said that superconductivity could have almost as much impact on mankind as electricity did a century earlier. Here is a sampling of potential electronics applications:

COMPONENTS

Analog/digital converter: The sampling rate of analog phenomena by a Josephson A/D converter is theoretically much faster than converters using conventional semiconductors, thereby markedly increasing the measurable frequency range.

Signal processors: Using high-temperature superconductors makes it possible to develop high-speed signal processors that operate at 50 times the sensitivity of conventional devices.

Optical switching devices: Potential applications range from fiber-optic communications systems to opto-electronic computers.

Sensors: A superconducting quantum interference device (SQUID) is the most sensitive detector of electromagnetic signals known. It comprises two Josephson junctions and can measure fields as small as one ten-billionth of the earth's magnetic field.

IC production: Synchrotron radiation is a million times more intense than the light from photolithography and so can be used to fabricate microchips with hundreds of millions of bits of memory on a single chip. Conventional synchrotrons are 100-feet by 100-feet in size. Using low-temperature superconductors, the size has been reduced to 6-feet by 15-feet.

COMPUTERS AND PERIPHERALS

CPUs: Since superconducting devices do not generate heat, circuits could be packed closer, permitting smaller, faster computers. One use is in board-level interconnects; another is in Josephson junction devices with switching times 10 times faster than semiconductor switches.

Motors: For cooling fans, computer peripherals. When a magnet comes near a superconducting material, the superconductor repels it — a feature that could be used to spin electric motors with 50% lower current losses. Superconductor motors are about one-third the size of a conventional motor.

Bearings: For ultra-fast disk drives, high-speed cameras, gyroscopes. Because a superconductor bearing will repel a magnetic shaft surrounding it, there is virtually no friction between the parts, and the self-stabilizing bearing can achieve very high rotation rates.

COMMUNICATIONS

Millimeter waves: Josephson junctions made of superconducting thin films have successfully detected millimeter waves, which are difficult to detect using conventional semiconductors. The available spectrum for communications could be doubled with superconducting materials.

Antennas: An antenna made of high-temperature superconductors can be made 5% the size required for a conventional antenna. A superconductor version 2.6-inches long can replace the normal 52-inch long antenna used for commercial FM reception.

MILITARY

Power lasers: Magnetic energy stored in huge underground superconductor coils circulates indefinitely without loss of power and when needed, can be discharged rapidly. Military uses include power lasers and devices such as rail guns that fire high-speed projectiles at incoming missiles.

Shields and waveguides: By repelling lines of magnetic flux and creating regions free of magnetic fields, superconducting shields could protect computer data.

Source: Superconductor Applications Association sensitivity by three orders of magnitude, to 10^{-7} gauss." That will likely happen over the next three years or so, he projects.

In addition, Japan's aggressive advances in superconductivity smash the long-cherished United States view that the Japanese, for all their talents in implementation, cannot break new technology ground. According to William Attridge, a Tokyo-based United States marketing consultant to high-tech companies: "Superconductivity is a test case in Japan's eyes of its newfound ability to innovate."

However, that ability is one that Japan values highly, and it's not all that difficult to imagine that the companies with the first superconductivity products will not be anxious to share their hard-earned secrets. Indeed, as the patents picture suggests, the Japanese are very hard at work seeking to ensure that they control as much of the proprietary technology surrounding superconductivity as possible by filing for patents.

The key question surrounding superconductivity, then, is not if, but when. And right now, the tea leaves are pointing very strongly toward Japanese dominance of this new technology. □

David E. Gumpert is editor and publisher of The Cambridge Report on Superconductivity, an industry newsletter based in Cambridge, Mass.

Take the fast train to Miyazaki

First come the warnings: Your quartz watch will probably stop. If you have a camera with a motor, it will probably not work. VCRs and tape recorders will likely be rendered ineffective and recorded materials could be lost.

Then the briefing: Today's top speed will be 280 kilometers per hour, reached at 0.3 g acceleration (although the train has previously reached a top speed of 400 kilometers per hour).

And finally: Don't forget to fill out your questionnaire assessing how you feel about the vibration, noise and seat comfort level.

Then comes the ride for 20 visiting Americans on a 70-foot-long white and red magnetically levitated rail car that looks like a plane without wings and feels like a plane without the engine noise as it speeds down the seven-kilometer test track. Though the train weighs 17 tons, it floats 10 centimeters above magnets on the track bed, thanks to superconducting niobium coils wound around magnets on the train and cooled to nearly absolute zero by helium-filled tanks. On the back of each airplane-like seat is a three-inch-square Casio liquid-crystal color television display, in case you want to watch a live video of the ride.

There are no engineers on this train. Instead, three technicians are in a control room operating the computer that turns the magnets on in sequence along the wedge-shaped "track" so as to accelerate and decelerate the train.

The mag-lev train is often cited as one of the more far-out applications of superconductivity, but in the Japanese resort town of Miyazaki, the mag-lev is here and now. Nearly 3,000 people have ridden the train since passenger cars were installed in early 1987. But only 30 of those people have been Americans.

The Japanese mag-lev has been under development since 1970 and, so far, has cost the government about $385 million. Since the passenger vehicle, known as the MLU002, began being tested last year, inquiries about constructing mag-levs have come in from such places as Las Vegas and Orlando, Fla., in the United States, Brazil, Australia and China, say officials.

But Japan isn't rushing off to another country to build a mag-lev, yet. "First it must be done in Japan and established as a good product," according to Hiroshi Takeda, deputy director of the Mag-Lev Development Division of the Japan Railway Technology Research Institute. Railway officials would like to see a 40km to 50km demonstration project between two Japanese cities to debug the train even further. He estimates the cost for such a project at about $1 billion. But he notes that a similar project in the United States could cost less.

However, to get the next Japanese version up and running will probably take about three years. By that time, Japan will be ready to tackle foreign markets. At the same time, Takeda is impressed with the potential American market — such corridors as New York to Washington, D.C. and Orlando to Miami. But what really makes his eyes light up is a country closer to home. "Just think of China . . ." according to Takeda, as his voice trails off. □

Gandhi: Foreign investment in India is not an "open door"

India's Prime Minister Rajiv Gandhi reaffirms his commitment to high-tech deals with the West. One catch: Business will be done only on India's terms

BY BRUCE C.P. RAYNER

In the four years that Rajiv Gandhi has served as Prime Minister of India, liberalization of the country's electronics industry has accelerated. It is no coincidence. Gandhi —who assumed India's leadership after the assassination of his mother, former Prime Minister Indira Gandhi, in 1984 —is a strong proponent of technological change. He constantly challenges both government and business to work toward a more efficient industry.

But while Gandhi is committed to a technological revolution, some critics claim the momentum is slowing. Still, Gandhi is adamant that the policy of liberalization started in the early 1980s will continue. In this, the conclusion of a two-part series, ELECTRONIC BUSINESS scrutinizes Gandhi's policies toward foreign businesses and examines India's telecommunications and computer markets.

During an interview with ELECTRONIC BUSINESS, the Cambridge University-educated Gandhi reaffirmed his commitment to past policies. When asked whether his country would continue to allow greater freedom for both foreign and domestic electronics companies in India, Gandhi's response was an adamant "absolutely."

Software, Gandhi says, is perhaps the most important area for growing investment by foreign firms. Since the government came out in late 1986 with a revised software policy, more emphasis is being given to the software industry's potential to attract foreign investment and generate exports.

The new policy is beginning to bear fruit. Last year, Microsoft Corp. inked a deal with an Indian software house to sell its packages in India, and this month Ashton-Tate is reportedly following suit. As for exports, India expects to ship $250 million worth of software this fiscal year ending in March, according to the Department of Electronics. Some of that much-needed foreign exchange is expected to come from a deal struck between the Commonwealth of Massachusetts and the Indian government for software exports from Pune, India to the U.S. market via Boston.

On opposite sides

Such relationships are a new phenomenon and look to be the wave of the future. But it was not so long ago that India and the United States were on opposite sides of the ideological fence. In fact, India is still angry with the United States for funneling arms through Pakistan to the rebels in Afghanistan. And the United States is not too keen on Gandhi's close ties with the Soviet Union. But business is business and Gandhi wants to insure India's technological growth will be tied to the West.

A quick guide to India

Fiscal year ending March 31.	1987	1988
GNP (constant $ billions)	$141.9	$144.9
Per capita GNP (constant $)	$184	$184
Population (millions)	770.0	785.4
Labor force (millions)	303.2	311.1
Balance of payments ($ millions)	$73.0	-$366.0
Balance of trade ($ billions)	-$6.52	-$6.42

Sources: GOI Central Statistical Organization, Reserve Bank of India, GOI Economic Survey, World Bank and U.S. Department of Commerce

To this end, India's leader made two visits to the U.S. during Ronald Reagan's presidency that helped to thaw relations between the two countries. On both visits, closer business cooperation, particularly in the electronics industry, was discussed with concrete results. Indeed, in 1985 the two leaders signed a memorandum of understanding which was a step toward easing restrictions on the transfer of U.S. high technology.

India desperately needs access to more technology if it expects to transform itself into a world class player. Gandhi accepts that this technological transformation "is not an event, it is a process." Last April, he acknowledged, "A successful transformation requires change across the board." That includes changes in government policies, changes in industrial and management tactics and changes in labor attitudes. "We must not be afraid of looking for new solutions to emerging problems," he added.

Supercomputer tiff

A case in point is the 1987 sale of a Cray Research Inc. XMP-14 supercomputer to India. After much political haggling — the United States feared the supercomputer would be used to develop nuclear weapons, although India promised it was for weather forecasting — the machine was reportedly shipped late last year.

While India looks to the West for its technological development, there is a caveat limiting the amount of foreign control that Gandhi will allow. He is serious about India's self determination and insists Western companies will not be permitted to bully their Indian partners. India's

Prime Minister of India Rajiv Gandhi is serious about India's self determination and insists Western companies will not be permitted to bully their Indian partners

Larry Barnes/Blackstar

foreign investment policy is not an "open door policy," he asserted.

"We permit foreign investment on our terms, in a wide range of sectors within certain percentages of foreign equity," Gandhi said. Those percentages of ownership are, for the most part, fixed at 40%. But while India will reexamine its centrally planned economy, there will always be room within that framework for foreign investment, he adds.

Gandhi told ELECTRONIC BUSINESS that one of the advantages that foreign companies can gain from working in India is the increased access it gives them to third-party countries. "We have certain expertise at working in difficult climatic conditions," he says, "for example, in rural telecommunications." Such expertise coupled with Western high tech can be a winning combination for sales to Africa, Asia and the Middle East, Gandhi asserts. Indeed, India's close economic ties with the Soviet Union and the Eastern Bloc countries can provide additional trade advantages for U.S. firms.

Whether Gandhi will be around to guide the country through its electronics transformation is up for debate. Some political analysts speculate that the election, slated for the end of 1989, could be a close race. The opposition parties are forming a coalition that, if it holds, might be strong enough to oust him from office.

Corruption charges within the ruling Congress party are rife and have even reached the inner circle of the Prime Minister's office. Critics also say that the country's civil unrest is taking up too much of Gandhi's time, preventing him from playing a stronger role in molding the country's technological future.

But like the rest of the world, Indians vote with their pocketbooks. And pocketbooks are now bulging. A fruitful monsoon season last year helped produce a bumper crop which will boost GNP growth back onto a 4% to 5% range, well above the lackluster 1.9% figure of 1987. What is more, inflation is falling, stock prices are up and business confidence is high, which could prompt Gandhi to call for an early election.

Furthermore, Gandhi's popularity has been waxing after Indian paratroopers squelched the attempted coup in the Maldives last November. Such a show of strength is good for a bit of political mileage, given the backdrop of strife that Gandhi is having with the Sikhs and the Sri Lankans. To add to his good fortune, the opposition is having its share of internal problems.

In fact, many pundits say Gandhi would be foolish not to call for an early election. By most accounts, it could take place as early as this March. If that is the case and Gandhi gets reelected for another five-year stint as Prime Minister, the country's electronics revolution should continue intact. ☐

Crackle, crackle . . . It's India on the line

India is planning to spend nearly $37 billion on telecom gear by the year 2000. The Japanese are eager. Where are the U.S. suppliers?

BY BRUCE C.P. RAYNER

Making a telephone call in India is often an exercise in futility. The connections are bad; the traffic is high; and the equipment is outdated. And that's on a good day. For most of the 800 million Indians, mere access to a telephone is out of the question. There are only about 4 million telephones in the entire country — and just 40,000 of those are public.

But all this is about to change. India's Department of Telecommunications (DOT), the central telecommunications authority, is planning to double the number of subscriber lines from about 4.0 million now to 9.5 million by 1995. It then wants to double that again to 20 million by the turn of the century.

Obviously, a lot of money will be spent. Ball-park estimates of around $37 billion to be spent over the next 11 years are being bandied about by the Indian government. The U.S. Department of Commerce estimates that $8 billion is earmarked for direct imports. U.S. companies, however, are hardly ecstatic. For various reasons, many U.S. suppliers have taken a somewhat lackadaisical attitude toward India. But other competitors, most notably the Japanese, have already begun to gear up for what could become one of the most lucrative markets for telecommunications equipment in the world.

Of the total $37 billion figure slated for telecommunications investment, $3 billion is earmarked for fiscal 1989, ending March of next year. Roughly $10 billion will be doled out from 1990 to 1995 and the remainder between 1996 and 2000, government sources say. Of the total investment, the government will only ante up about half. The rest will come from private investors, both foreign and domestic.

Krishna Tanuku, regional vice president of newly formed AT&T India Ltd: "India is one of the major growth opportunities in developing nations"

Steve Richards

High on India's must-have import list are transmission and test equipment, traffic generators, pay phones and a host of business and office telecommunications equipment. India is also hungry for fiber-optic technology and components so it can get its domestic producers up to speed. The long-term strategy is to install a digital fiber-optics-based system.

For foreign telecommunications firms with little or no history in India, the best point of entry is in the business market: facsimile machines, modems and local area networks are all areas targeted for growth. It's no wonder, given the shortage of such equipment in India. There are currently only about 500 fax machines there, according to one government source.

Now is the time to act, assert market gurus, before import opportunities quickly dry up as more Indian companies start producing these types of equipment. Because of the government's favoritism toward domestic companies, foreign firms could soon run into high import duties and, perhaps, out-and-out bans, fear pessimists. One alternative is to set up a joint venture with an Indian company and begin local manufacturing.

For United States suppliers hoping to get a piece of the action, a good starting point for gathering information is the United States Department of Commerce, which led a telecommunications mission to India last year. In addition, another option is the country's major engineering trade show, scheduled for next month in New Delhi, which offers a forum to

India's ambitious telecommunications plans

	1988	1990	1995	2000
Local telephone connections (millions)	3.2	4.5	9.5	20.0
Telex connections (thousands)	30	55	100	200
Villages having public telephones or exchanges (thousands)	32	43	100	600
Voice/data connections for business/industry (thousands)	few	10	100	800
Capital investment needed ($ billions)	$3.62	$7.05	$17.11	$36.58

Figures are on an installed basis
Conversion rate: 14.9 rupees = $1

Source: Department of Telecommunications, Government of India

explore telecommunications and electronics business oportunities there.

Fiercely independent

In typical Indian fashion, the country is pursuing a fiercely independent telecommunications strategy. India is unique, insists Sam Pitroda, Advisor to the Prime Minister for Technology Missions. Consequently, Pitroda contends that the country has unique demands for a national telecommunications system that differs markedly from those in the West. Pitroda is a key player in shaping India's telecommunications policy. However, he strongly advocates an indigenously developed and built telecommunications system that limits imports to subsystems and components as needed.

Pitroda's vision is being implemented. A program is underway to put telephones in India's 600,000 or so villages, a daunting task as only about 35,000 villages are currently serviced.

For the job, the Center for the Development of Telematics (C-DOT), a government agency, designed a rural automatic exchange (RAX) to survive with minimal maintenance in India's harsh climate. Even though the project is domestic, a lot of the components are coming from overseas, says Sunil Abrol, C-DOT's registrar. So far, 25 RAXs have been installed and the DOT plans to have a total of 400 installed by the end of 1989, says Abrol. In the last four years, C-DOT also designed two other exchanges: a PBX system that has so far been installed in 300 offices and a main exchange that is up and running in New Delhi and Bangalore.

All three of these domestically developed exchanges are manufactured by both private and public companies in India. Other government-sponsored projects include digital multiplex equipment, digital microwave systems and satellite communications equipment, all of which utilize domestically produced parts.

For most of the 800 million Indians, mere access to a telephone is out of the question

This indigenization kick is a radical departure from the past. Over the last 40 years, when all the big switching and transmission contracts were being tendered, the companies that got the business were all European. Many of the contracts were tied to economic aid packages. France's Alcatel got a number of big switching contracts and companies like L.M. Ericsson, N.V. Philips and Siemens AG scooped up the rest. American companies simply missed the boat.

But with this new opportunity to participate in the market, many American companies have no intention of being left out again — especially not AT&T. "Just because we were late for lunch, doesn't mean we will be late for dinner too," states Krishna Tanuku, regional vice president of newly formed AT&T India Ltd.

Tanuku heads a liaison office in New Delhi which was set up to explore India's telecommunications needs. "India is one of the major growth opportunities in developing nations," he says. As examples of possible opportunities for AT&T, Tanuku points to possible collaborations with C-DOT as well as technology transfers to Indian companies in areas like fiber optics. Besides telecommunications, opportunities exist in Unix and other business computer applications, he adds.

Not everyone shares AT&T's optimism. Rockwell International Corp.'s communication systems division, headquartered in Irvine, Calif., also has a New Delhi liaison office which is keeping its eye out for business opportunities. But Gilbert Amelio, the division's president, says that new business is very slow in coming.

"Everything is highly politicized," Amelio complains, referring to the tight reins the DOT keeps on growth and limits to foreign ownership. While he claims to be interested in setting up a joint venture in India — possibly with C-DOT — the Rockwell executive insists the 40% foreign ownership cap is a serious concern. At this point, India is simply not a priority, he adds.

With that kind of attitude, Rockwell might miss out on India's telecommunications boom as history threatens to repeat itself. But this time, instead of the Europeans, the new challengers will be coming from Asia. Japan has been making a strong showing in India over the last few years and looks to be intensifying its efforts. Companies like Fujitsu Ltd., Furukawa Electric Company Ltd., Oki Electric Industry Company Ltd. and Tamura all already have lucrative technology transfers and joint ventures in India. So, unless the U.S. begins to act now, it could find itself dialing the wrong number as the year 2000 approaches. □

Foreign firms chip away at the U.S. defense arsenal

The military electronics marketplace is no longer as American as apple pie. Foreigners are making inroads. Here come the Japanese

BY BRUCE C.P. RAYNER

The Department of Defense (DOD) is growing nervous about the increasing foreign content in its $300 billion a year defense arsenal. While the percentage of prime contracts awarded to foreigners has remained relatively constant over the past few years, there are indications that the foreign content of electronic components in subcontracts — for which there are no official figures — is on the rise.

Foreign vendors — through their U.S. subsidiaries — are also becoming more active in the U.S. military electronics marketplace. Some are teaming up with U.S. defense manufacturers to bid on Pentagon contracts. Others are going directly after U.S. contracts.

To many on Capitol Hill, the increasing globalization of the military electronics market is a disturbing trend. In fact, in a recent study by the General Accounting Office conducted for Sen. John Heinz (R-Pa.), the GAO concluded that "in a national emergency, the consequences of extensive dependence on foreign sources could be extreme."

Says a spokesperson for Heinz: "It makes you nervous that we are in fact not procuring from the domestic base to a greater extent." One of the primary jobs for Robert McCormack, the newly appointed Deputy Undersecretary of Defense for Industrial and International Programs, is to analyze the extent of this foreign dependence.

The industry segment which has been singled out for the most attention is, of course, semiconductors, the 13th most critical industry for national security, according to the Logistics Management Institute (LMI), a government research center. In total, the DOD buys 27.6% of America's total consumption of chips. Of that total, about 30% is sourced offshore, the LMI estimates.

To some extent, the U.S. government's $100 million a year stake in Sematech, the Texas-based semiconductor consortium, is a direct result of the DOD's concern with foreign dominance in semiconductors. [See ELECTRONIC BUSINESS cover story, May 1, 1988.] But what may be even more disturbing than the rise of the Asian semiconductor industry, defense analysts say, is the direct investment in the U.S. industrial base by foreign firms.

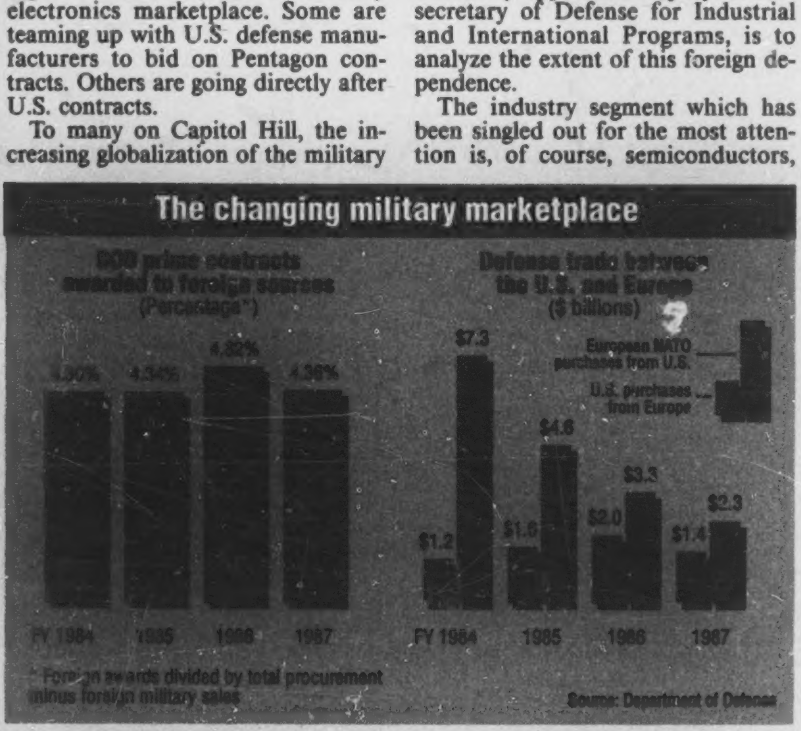
Foreign direct investment rose from $83 billion in 1980 to $209 billion by 1986, reports the Bureau of Economic Analysis. In 1986, 32.5% of that was in manufacturing. At the same time, U.S. direct investment abroad has grown more slowly, from $215 billion in 1980 to $260 billion in 1986.

The Defense Department publicly insists that it is not concerned with the trend, as long as it can insure the integrity of national security. However, privately, many defense and government officials are worried, say European defense executives.

European competition

"Right now there is a wave of protectionism that is running quite high, based on the amount of foreign investment, primarily in the political arena," comments James Bell, president of Thomson-CSF Inc., a U.S. defense subsidiary of Thomson-CSF, the largest defense electronics manufacturer in France.

European military contractors say their American counterparts are wor-


The changing military marketplace

* Foreign awards divided by total procurement minus foreign military sales

Source: Department of Defense

While the percentage of U.S. prime contracts awarded to foreigners remains relatively constant, the defense trade with Europe is becoming more balanced

Marty Braun

ried because while foreign prime contracts account for about $4 billion of the DOD's annual budget, the amount of contracts going to foreign-owned U.S. subsidiaries is rising.

Meanwhile, European defense firms are aggressively pursuing U.S. expansion. The dollar's fall over the past few years has meant lucrative U.S. investments, while shrinking European defense budgets have forced many companies to look elsewhere for business.

But strategies differ among European military contractors with offices here. As a rule, the British are the most aggressive, partly because of the close government-to-government ties between Britain and the United States. Britain's Plessey Company Plc, for example, is busy buying up U.S. and Canadian defense companies, while British Aerospace (BAe) boasts a total of 23 collaborative ventures with U.S. firms. BAe recently bought Reflectone Inc., a Tampa, Florida-based simulator company, to add to its war chest.

Germany's Siemens AG — which recently joined General Electric Co. (GEC) of Britain (no relation to the U.S. General Electric Co.) in a $3.12 billion bid to take over Plessey — is actively teaming up on a variety of defense contracts with the likes of Boeing Co., Litton Industries Inc. and Texas Instruments Inc. Aside from the bid for Plessey, acquisitions of military vendors in the United States are not in the cards, according to one Siemens spokesperson.

About 30% of the DOD's chips are sourced offshore

Thomson-CSF is also fighting for its share of the U.S. military electronics market. "To maintain and increase your market share, you have to look at ways to get into bigger and more complex activities," comments Thomson's Bell. The company's big success in the United States is its 1985 team-up effort with GTE's Government Systems Corp. to adapt its RITA battlefield communications system for the U.S. Army's Mobile Subscriber Equipment program.

Thomson's goal is to double its $340 million sales in the U.S. defense market within the next five years, says Bell. It is doing that through an "aggressive marketing drive" that includes acquisitions — it purchased Wilcox Electric Co. in early 1988 — as well as marketing efforts on behalf of the RITA system to the U.S. Marines and the U.S. Air Force.

The wild card

While the Europeans are pounding away on the U.S. market, the real wild card in the 1990s is going to be Japan, analysts claim. While some say the constitutional ban on defense exports is strong enough to prevent Japan from selling internationally, others believe politicians will be able to sidestep the limitations.

It is only a matter of time, these analysts say — maybe five to 10 years — before the country enters the international defense marketplace. The cracks in its resolve are already showing. For starters, Japan is participating in the Western Pacific Strategic Defense Initiative umbrella with the U.S. Department of Defense.

"The U.S. has an interest in a number of technology areas in Japan, and I think, over time, there will be more activity in this regard," says Robert Martin, director of Asian and Latin American operations at the System Planning Corp., a defense consulting and contracting firm in Arlington, Va. Particular areas of interest to the United States are laser technology, demagnetizing technology for ships, fiber optics, avionics guidance systems and manufacturing process technology, sources say.

However, Martin believes the Japanese are in no rush to jump into the international marketplace. This is partly because of their constitutional constraints and partly because "they don't want to give away their technology to the Yanks," he says.

The real test of Japan's international intentions will be the FSX, says Robert Fraser, senior defense analyst at Arthur D. Little Inc. Even though it is built around the F-16 shell, Fraser believes the FSX will bear little resemblance to the F-16 when it rolls off the production line in the mid-1990s. In fact, most of the high-tech avionics will be stamped "Made in Japan." By that time, many believe, Japan's Ministry of International Trade and Industry (MITI) will have effectively dismantled the Japanese government's constraints on exporting defense goods.

But even if Fraser is wrong, the Japanese will continue to penetrate the U.S. defense market via the commerical channel. A case in point is a small Southern California company (whose president requested anonymity) that is manufacturing rate sensor packages — gyroscopes, excellerometers and electronics packages — for the Air Force. It is using technology instead of components supplied by Japan Aviation Electronics, Mitsubishi Heavy Industries and Mitsubishi Electric Corp. in one $380,460 contract.

The president of the contracting firm admits that he intends to develop closer ties with Japanese companies in hopes of taking advantage of technology transfers in the future. This is one forward looking U.S. company that is betting on the Japanese taking the FSX global. ☐

What lies ahead — A view from the top

Deputy Undersecretary of Defense McCormack discusses the implications of globalization on the U.S. defense industry

Robert McCormack, the Deputy Undersecretary of Defense for Industrial and International Programs, as of October 1, 1988, has the thankless — and according to some critics, impossible — task of bringing these two seemingly conflicting programs into harmony. If he can hold onto the job in the new Bush administration, McCormack will be the man to watch as the DOD shapes policy for the "globalization" years of the 1990s.

The newly created position traces its origin to a July 1988 report by Robert Costello, Undersecretary of Defense for Acquisition, which recommends ways to bolster the defense industrial base. Among other things, Costello charges McCormack with improving manufacturing programs, providing visibility into foreign military dependency and increasing activity in the Pacific Rim. A tall order, to say the least.

McCormack recently spoke with ELECTRONIC BUSINESS *on what lies ahead for the U.S. defense industry. Following are some of his comments.*

EB: How will your office begin to try to minimize foreign dependence on foreign electronic components?

McCormack: The issue is not minimizing foreign dependency as the first order of business. The issue is to determine where that type of dependency exists. So the first question is to identify whether there could be a problem of sourcing something in the event of an emergency. The way that is going to be implemented is that the services themselves — as they are looking at their procurement of weapons systems — are going to take a look at that.

In other words, if they are assuming they are going to be able to buy 50% more of X [a weapons system] over some period of time, the question is: can you indeed do that, and can you determine what the vulnera-

What it takes to get through a DOD audit

Surviving an audit can make the difference between winning and losing a defense contract. It can also make the difference between going to jail and staying in business

BY BRUCE C. P. RAYNER

When the Defense Contract Audit Agency comes knocking on the doors of defense electronics firms, executives had better be prepared. Recently, however, many defense contractors have *not* been prepared. The number of fraud cases and suspensions is climbing and the value of contractor overcharges is rising. Is the DCAA cracking down or are contractors slacking off?

The answer is: both.

The simple fact is that employee ignorance is at the heart of many cases of overcharging, according to Phillip Rogers, executive officer at the DCAA, the government's defense auditor. "A lot of the time company employees just don't know what their responsibilities are," according to what Rogers says. That is serious: not reporting updated material costs or not keeping accurate track of hours worked is tantamount to criminal negligence.

A Pentagon source estimates that the DCAA uncovered overcharging on nearly 50% of all contracts reviewed over the past two years. How much resulted from criminal wrongdoing as opposed to sheer ignorance, however, is unclear. Still, the discrepancies translate into big bucks. In fiscal year 1988, the DCAA says it saved taxpayers $9.5 billion on overinflated defense contracts.

The bottom line

The bottom line for defense contractors is that the DCAA is finding more to complain about. And, because of the DCAA's power over contractors, there is little love lost between the two. Many contractors complain that the DCAA taxes their already overtaxed financial departments and some accuse the auditors of overkill and nitpicking. They argue that auditors waste both time and money in their endless paper chase. One contractor estimates the annual cost of audits at between 2% and 3% of total sales.

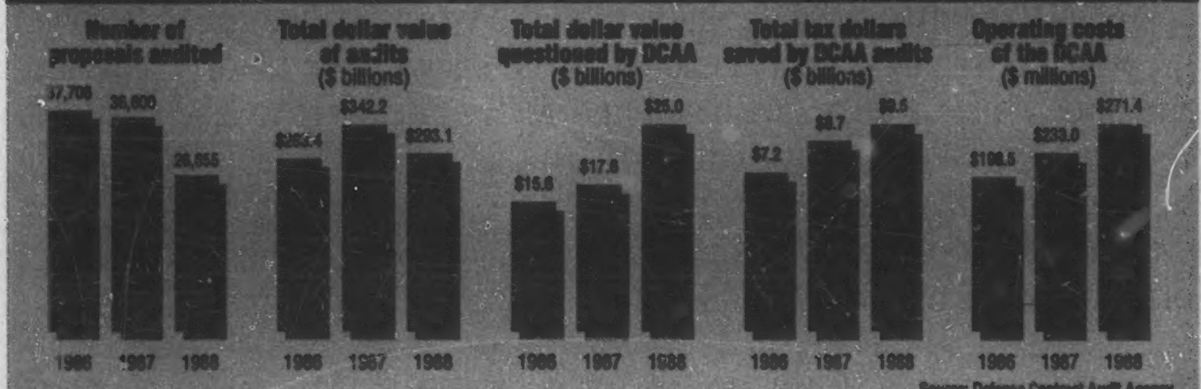
The DCAA conducts a variety of audits. Most common are the proposal audit and the incurred cost audit. The first evaluates a contractor's proposal and looks at the cost breakdown. The second looks at the costs of an already awarded contract to see if the incurred costs match the projected cost.

In light of recent defense scandals, the DCAA is recommending tighter regulations. The agency has suggested stricter guidelines for hiring consultants. And a few years ago, it began streamlining its fraud referral procedure. In fiscal 1987, 287 referrals were made — an 86% increase over the year before — according to congressional testimony by Fred Newton, deputy DCAA director.

In fiscal 1988, however, that figure dropped to 191. The 33% decline is attributed to an increase in voluntary disclosures and an increase — to over 1,000 — in the number of contractors debarred or suspended from bidding on defense contracts, says the DCAA's Rogers.

The crackdown ironically comes at a time when the DCAA says it is sorely understaffed. The Defense Department requested an additional 1,025 auditors. But until they materi-

What the DCAA does for a living



Source: Defense Contract Audit Agency

alize, the agency relies on "risk assessment" in determining who gets audited and to what extent.

Prime targets include big contractors and subcontractors with over $10 million in auditable contracts; any contractor with a problem track record; and any new players to the game. The DCAA auditors pay particular attention to contractors that are simultaneously working on both cost-plus and fixed-price contracts in house.

Corporate education

For the concerned contractor, the answer to surviving a DCAA audit is corporate education. That doesn't just mean educating the executives, but *all* the employees who play a part in the contract process. Rogers recommends participation in the Federal Acquisition Regulation (FAR) self-governance program as a way to prove to the DCAA that the company is serious about internal education.

Rogers suggests that companies conduct employee training programs explaining the importance of such issues as The Truth in Negotiation Act, a law requiring defense contractors to supply current cost and pricing data on noncompetitive contracts up to the time the contract is awarded.

The DCAA insists that most contractors maintain comprehensive financial and cost accounting systems in keeping with Congress' Cost Accounting Standards (CAS), as well as the standards of the American Institute of Certified Public Accountants. These are necessary for accurately capturing costs and estimating rates, says Rogers. Small businesses generally aren't required to comply with CAS, though many do simply because it makes good business sense.

As an added safeguard, Rogers suggests contractors employ an outside auditor, preferably a Big Eight accounting firm, to check the books even if the company is privately held. The more closely held the company and the more heavily guarded the books, the more the DCAA will want to dig, he says.

For newcomers to the defense game, the DCAA offers a pamphlet called "Guidance for New Contractors," a good starting point for information gathering. Contractors also recommend membership in the National Contract Management Association, based in Virginia.

Contractors, however, aren't wildly enthusiastic about DCAA auditors. They "should use some common sense in what they really have to audit," says William Tannaz, director of contracts at MagneTek ALS, maker of the power supply for the U.S. Navy's AEGIS CG-47-class guided-missile cruiser. For example, in 1988, the DCAA was requested to audit the company's old insurance policy from when it was a small business, even though ALS had already been acquired by MagneTek Inc., a large company. (Whenever a small company becomes a large company, the reporting requirements change.)

Another criticism is that for in-house DCAA auditors, the company winds up training new auditors. Richard Foster, president of Interstate Electronics Corp., a Figgie International Inc. company, claims that of the eight auditors that Interstate houses, only three have more than one year of experience. "There are tremendous inefficiencies in the process," Foster says.

The audits can be expensive in more ways than one. Last October, Sundstrand Corp. paid $127 million in fines, damages and penalties for mischarging on government contracts. In August, TRW Inc. was hit with a $6 million bill after pleading guilty to overcharging.

But while contractors complain about the time and effort it takes to satisfy the DCAA, they all grudgingly agree the audits are necessary. To make the process easier, what is needed is a closer, more cooperative, relationship between the contractor and auditor, they say. Translation: the contractor must always be ready to open the books on demand. ☐

Blow by blow: One real life audit drama

Interstate Electronics submits an $8.4 million bid to the Air Force and opens its doors to government auditors

The best way to provide insight into the audit process is to spell it out, step by step. What follows is a case study of a proposal audit by the Defense Contract Audit Agency (DCAA) of a fairly typical defense electronics firm.

On May 11, 1987, Interstate Electronics Corp. of Anaheim, Calif., submitted a "best and final" $8.4 million bid to the Air Force for a range application translator for a global positioning system (GPS), which provides positioning data for tracking satellites and missiles. Interstate, a subsidiary of Figgie International Inc., is a leading maker of test instrumentation for weapons systems, intelligence and electronic warfare systems, as well as flat-panel display technology.

By the end of May, the Air Force's procurement contracting officer (PCO) had made a request for a proposal audit of Interstate through the Defense Contract Administration Service (DCAS). The DCAS is the contract management arm of the Defense Logistics Agency and oversees the majority of Defense contracts. In most audits, the PCO contacts the administrative contract officer (ACO) at the local DCAS office, and the ACO, in turn, contacts the local in-house DCAA auditors at Interstate's Anaheim facility.

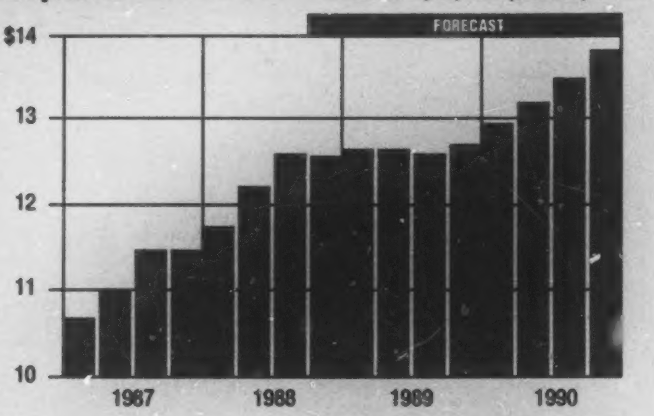
While the DCAA was doing its cost audit, the DCAS conducted a technical review of the GPS translator. The DCAS auditors evaluted engineering plans and determined whether or not the materials and labor that the company said it needed to build the translator were legitimate. The DCAA auditors, on the other hand, looked into the cost reporting and rate estimates that the company submitted in its bid to the PCO. In total, these two "physical" audits lasted about 30 days. The entire audit process, including report writing, took 45 days.

Both Interstate's pricing depart-

Scientific & engineering instruments

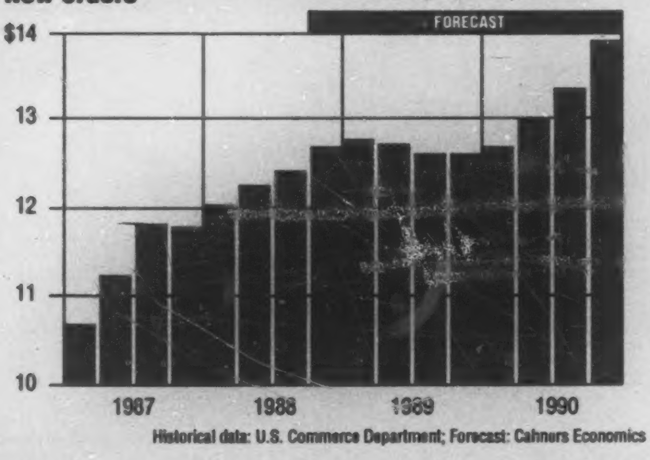
Shipments

Seasonally adjusted ($ billions)



New orders

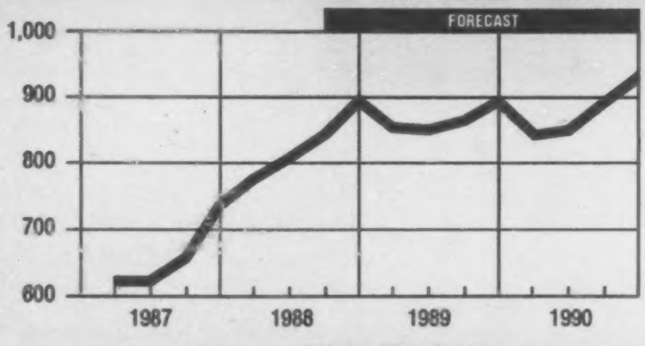
Seasonally adjusted ($ billions)



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

ELECTRONIC BUSINESS ATE sales index

First quarter 1976 = 100



Historical data: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Instruments posted a 10% sales gain in 1988

In the first 10 months of 1988, shipments of scientific and engineering instruments climbed to $40.66 billion, a gain of almost 10% from the level in the January through October period of 1987. It looks like once all the data is tabulated for 1988, the annual increase will end up being about this same amount. This rise will be on top of the 9.5% hike in shipments the industry reaped back in 1987.

While 1988 will go down on the books as a good year for sales gains, it also marks the end of the expansionary phase of the current business cycle and a turn into a period of slower growth. In particular, increases in new orders for scientific and engineering instruments started trailing off last year. In the first quarter, new orders surged 12% from the same period in 1987, while in the second quarter, growth was about 9%. However, by the third quarter, the hike to the comparable three months in 1987 dropped to 5%.

But, the scientific and engineering instruments industry is expected to weather the business contraction without getting totally squeezed off. U.S. factory shipments of these instruments is still forecast to crawl up another 3% in 1989, bringing the annual figure to $50.6 billion. One factor helping this industry is its level of backlogs. For the month-end of October 1988, unfilled orders were valued at $12.96 billion, about 5% ahead of the previous year.

According to the ELECTRONIC BUSINESS ATE Sales Index, the automatic test equipment sector was a star player in the overall industry's performance. In the third quarter of 1988, the ATE Sales Index swelled 28% from the same quarter a year earlier. For all of last year, worldwide sales are expected to total $2.26 billion.

Because the ATE market is so strongly affected by the volatility in the semiconductor industry, its business cycle swings tend to be more pronounced, too. But, better inventory management and export opportunities are expected to translate into more stable growth for ATE this year. The ATE Sales Index is expected to jump about 4% in 1989. In general, the need for increased efficiency and quality to remain competitive and boost market share will continue to spur sales of test, measurement and inspection equipment this year.

MADELINE FRANCHI

Computer output still heading up

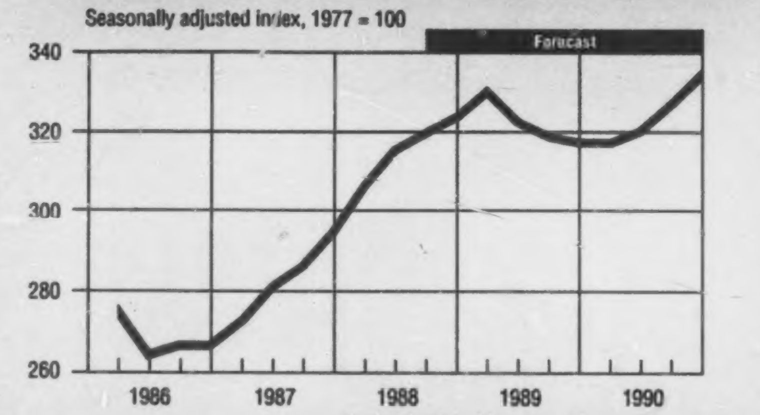
Average industrial production of computers and office machinery in the third quarter swelled 12% from the same period in 1987. Average quarterly output has been on an uninterrupted rise since the first quarter of 1987 as businesses ordered more information-processing equipment. In the July through September period, private purchases of computer and office equipment reached an annualized $41.8 billion, a gain of 12% over last year's third quarter.

A portion of production has gone to restocking of inventory and meeting foreign demand. At the end of September, inventory valued $11.8 billion, or 15% above the $10.3 billion estimated in September 1987. Third quarter exports expanded 21% from third quarter 1987 to total almost $5.6 billion.

Output levels will keep rising through part of 1989, but the rate of growth will start to ease soon. Evidence is filtering in that the expected slowdown in the industry has started. Although new orders and shipments in the waning months of 1988 were still above their respective 1987 levels, the rate of that growth was getting smaller than earlier in the year. October shipments confirmed this trend. From September to October, shipments fell by 1.4% to $5.69 billion. This left the monthly book-to-bill ratio at 0.96, which was the second month the ratio was below 1.0.

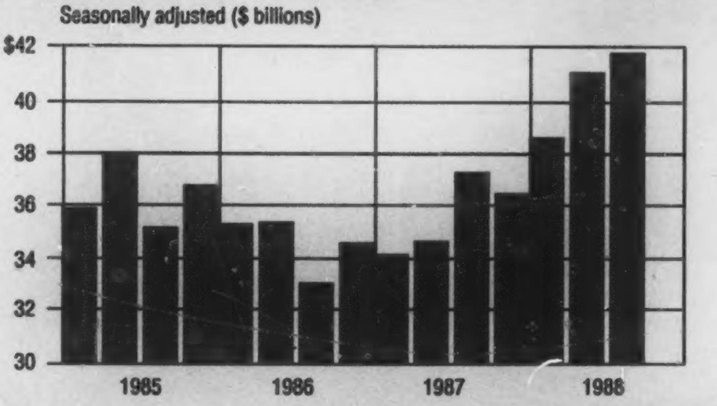
MADELINE FRANCHI

Computers and office machinery — Industrial production



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Computers and office machinery — Purchases



Source: U.S. Commerce Department

Computer market database

Latest quarter: 3rd quarter 1988	Latest quarter	Previous quarter	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, qtr. average)	319.5	315.0	+1.43%	285.0	+12.11%	318.3	-0.38%
Shipments (SA, $ millions, qtr. total)	$17,406	$17,290	+0.67%	$15,661	+11.14%	$17,183	-1.28%
New orders (SA, $ millions, qtr. total)	$17,306	$17,381	-0.43%	$15,639	+10.66%	$16,515	-4.57%
Unfilled orders (SA, $ millions, qtr. total)	$13,720	$13,820	-0.72%	$14,114	-2.79%	$13,385	-2.44%
Inventory-to-shipment ratio (SA, end of qtr.)	2.03	1.91	—	19.92	—	2.05	—
All employees (thousands, end of qtr.)	518.0	513.9	+0.80%	486.2	+6.54%	515.7	-0.36%
Production workers (thousands, end of quarter)	167.3	168.3	-0.59%	164.6	+1.64%	165.0	-1.46%
Exports ($ millions, qtr. total)	$5,596	$5,638	-0.75%	$4,635	+20.74%	$5,994	+7.12%
Imports ($ millions, qtr. total)	$5,759	$5,558	+3.62%	$4,897	+17.61%	$6,213	+7.89%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

NOTE

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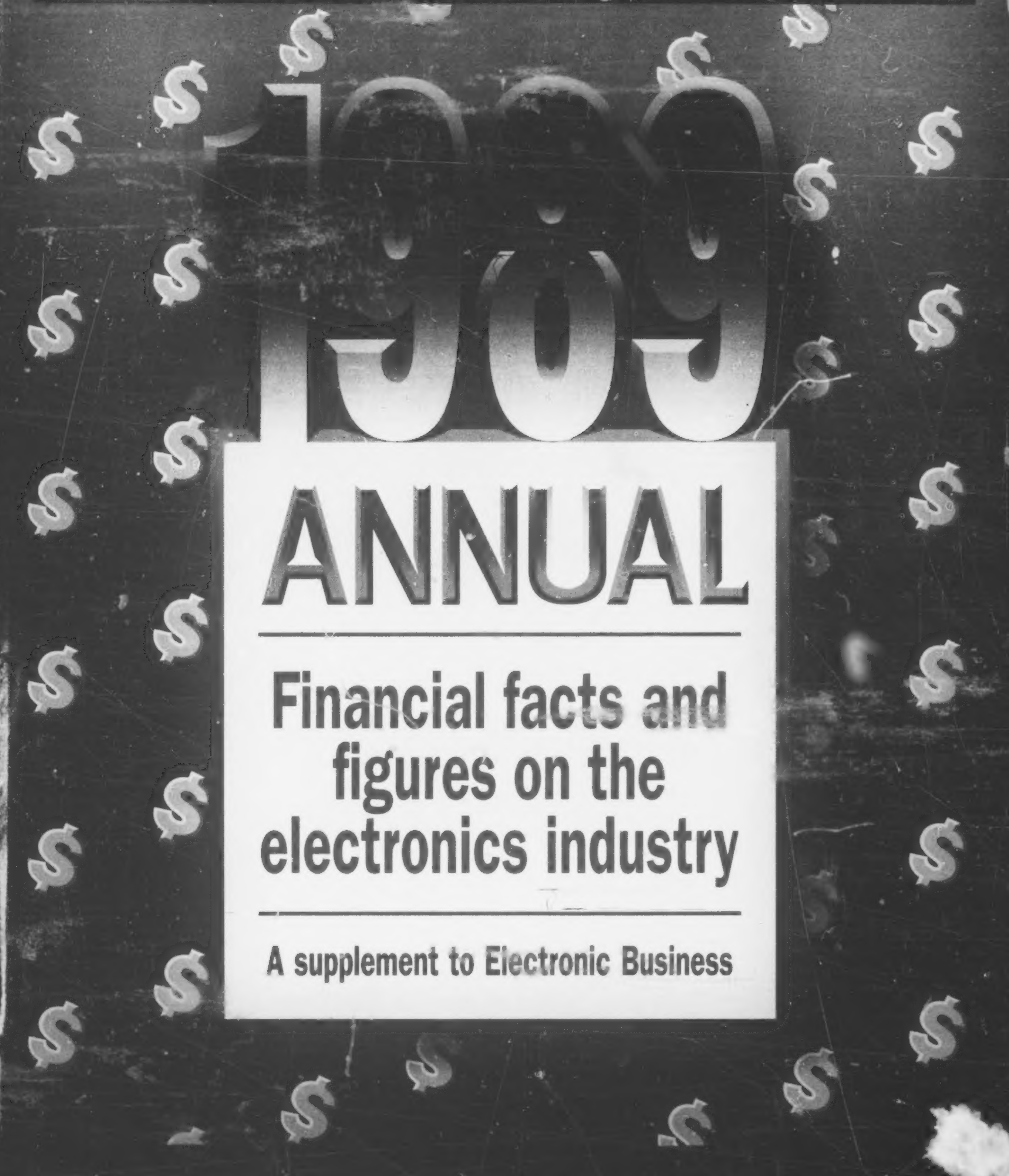
Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

JANUARY 23, 1989



1989

ANNUAL

Financial facts and figures on the electronics industry

A supplement to Electronic Business

1989 ANNUAL

Financial facts and figures on the electronics industry

A supplement to Electronic Business

All the world loves a winner, and never more so than when the interested party shows up at the top of the league. The next best thing is gauging your company's financial performance against that of your competitors — and finding that you're ahead.

But the comparisons go nowhere without hard data from authoritative sources. The editors of ELECTRONIC BUSINESS are proud to bring you that information in this special supplement, a compendium that will prove a valuable reference tool in the years to come.

The supplement pools eleven of the best rankings published in the 1988 issues of ELECTRONIC BUSINESS, from the widely quoted ELECTRONIC BUSINESS 200 to a rating of the 100 electronics companies that produced the highest return on investment. Each is the product of painstaking, original research by our staff editors; collectively, they support our stance that electronics is a truly global industry.

Kicking off the supplement is the ELECTRONIC BUSINESS 200, a listing by revenue of the top 200 publicly held U.S. electronics companies that is as important to senior electronics executives as the *Fortune* 500 is to the broader business world. The "200" spins off plenty of value for our readers: the ranking of the fastest-growing firms, and the list of top ROI performers, for example, owe their origins to the Sisyphean number-crunching that goes to make up the top 200.

But the electronics industry does not start in Silicon Valley and end inside Boston's Route 128 beltway. Japan needs no introduction as the other industrial giant, and Europe is re-emerging as the vital "third force" — hence our rankings of the top electronics players in those sectors of the globe.

For those with a corporate passion for beating the IRS, there's invaluable detail on which companies paid what taxes. And if you like keeping track of how much the top brass really make, then the dollar figures on the top 100 highest-paid executives will give you plenty to go on. Enjoy.

JOHN KERR, editor

TOP PERFORMERS IN ELECTRONICS, COMPUTERS AND SYSTEMS — WORLDWIDE

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100 **Top paid executives**
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146 **Top taxpayers**
For the 130 companies on this year's list, the average effective tax rate dropped to 39.4%. Over 60% of taxes went to foreign governments.

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The 200

Sky-high and heading higher

The signs are positive. Total net income for the 200 leaders rose more than 50% to $41 billion after two years of declining growth

After the exuberant highs of the early days and then the shocking reversal in 1985, the electronics industry is finally settling down. No longer driven by uncontrolled growth, the new, mature industry is more interested in expanding profits than revenue. Today's cautious managers now see that the wild growth that turned so many start-ups into market leaders also ultimately turned many market leaders into losers.

This message is especially clear to executives whose companies have significantly increased their standings in this year's ELECTRONIC BUSINESS 200. Of the top 200 electronics companies ranked annually by this magazine, 93 firms advanced on the list this year over positions they previously held, and 21 companies joined this list.

"Profits are our No. 1 concern; size is way down the list," says Paul Eder, senior vice president of Anthem Electronics Inc., a leading distributor. "We would rather be a profitable midsized company than a large also-ran." This year, Anthem rose 32 slots on the ELECTRONIC BUSINESS 200 —to No. 166.

Eder echoes the sentiments of many executives. Indeed, in 1987 the industry's top performers kept both eyes sharply focused on the bottom line. As a result, total net income for the 200 leaders rose more than 50% to $41 billion after two years of declining growth, according to the ELECTRONIC BUSINESS 200. Electronics sales, by comparison, grew 7% to $299.2 billion for the calendar year. Since 1983, sales have risen 10.7% compounded annually. Net income, meanwhile, has increased 13.9% a year during the five years. ▷

BY BETH KARLIN and LINDA STALLMANN

ELECTRONIC BUSINESS 200

FINANCE

The ELECTRONIC BUSINESS 200 is an exclusive report by ELECTRONIC BUSINESS magazine analyzing the financial statements of the 200 largest United States-based computer and electronics manufacturers. It is based on a careful analysis of hundreds of annual reports, 10-K Reports, interviews with company executives and estimates developed internally at the magazine. As such, the 200 — which only includes publicly held companies — provides an accurate gauge of the current status and future direction of the U.S. electronics industry.

And the prognosis is good. After spending two years streamlining operations, many of the ELECTRONIC BUSINESS 200 are well positioned for steady growth. And those that aren't are rapidly moving in that direction (see accompanying story). To see what the successful ones are doing right, ELECTRONIC BUSINESS closely studied the strategies of companies that vastly improved their standings in the ELECTRONIC BUSINESS 200 between 1986 and 1987.

For example, workstation maker Sun Microsystems Inc., with the largest sales growth rate this year, moved up 28 spots to No. 65. And Mark IV Industries Inc., a diversified manufacturer of industrial products — and next fastest growing — jumped 64 positions on our listing — to spot 116. Along the way, however, these companies didn't blindly sacrifice profits at the altar of revenue. Indeed, Sun's net income nearly doubled in 1987, while Mark IV's climbed to almost 80%. "Our goal is to repeat what we have done well, learn from our mistakes and produce real returns at the operating unit level of a minimum of 15% of sales," says Sal H. Alfiero, Mark IV chairman.

Not by chance

Growth like this doesn't happen by chance. Rather, the winners have carefully orchestrated their successes. Key to that success is implementation of strict financial controls and an emphasis on profits.

"It takes strong concentration to focus on specific products or niches with profit potential when most of the competition is chasing sales volume," says Jerry Kalov, president of Dynascan Corp., a Chicago consumer electronics company that went from a $17 million loss from continuing operations in 1984 to a $6.6 million profit in 1987. "But if a product doesn't make a profit, we won't sell it." While that may seem obvious, many electronics companies owe their demise to aggressive marketing of products for all the wrong reasons — merely to expand their product lines, for example, or to get into new market segments without regard for profit potential.

No longer. In 1987, the emphasis on the bottom line forced many companies to completely rethink their corporate philosophies. While strate-

Composite performance of the ELECTRONIC BUSINESS 200

	1983	1984	Percentage change	1985	Percentage change	1986	Percentage change	1987	Percentage change
Electronic sales ($ billions)	$225.9	$256.2	+13.4%	$267.8	+4.5%	$279.2	+4.3%	$299.2	+7.2%
Total sales ($ billions)	$732.5	$776.5	+6.0%	$797.8	+2.7%	$641.7	-19.6%	$689.7	+7.5%
Net income ($ billions)	$37.4	$46.4	+24.1%	$35.4	-23.7%	$26.7	-24.6%	$41.0	+53.6%
Weighted averages:									
Return on equity	13.8%	16.5%	—	11.8%	—	10.2%	—	14.1%	—
Return on investment	10.2%	12.6%	—	8.7%	—	7.2%	—	10.1%	—
Cost of goods sold as a percentage of sales	70.0%	69.4%	—	70.3%	—	63.7%	—	61.5%	—
R&D as a percentage of sales	4.1%	4.2%		4.2%		5.0%		5.2%	—
Sales per employee	$97,300	$103,200	+6.1%	$110,800	+7.4%	$102,348	-7.6%	$113,533	+10.9%
Net income per employee	$5,100	$6,300	+23.5%	$5,000	-20.6%	$4,266	-14.7%	$6,662	+56.2%
5-year compound growth:									
Sales	+8.5%	+8.5%	—	+5.0%	—	+8.2%	—	+10.7%	—
Net income	+7.3%	+11.6%	—	+1.4%	—	+4.0%	—	+13.9%	—
Capital outlay to net cash flow after dividends	89.8%	96.0%	—	118.3%	—	97.9%	—	73.9%	—
Debt as a percentage of total capital	26.1%	23.5%	—	26.7%	—	29.9%	—	28.2%	—
Foreign sales as a percentage of sales	—	—	—	14.0%	—	25.4%	—	24.9%	—

gies vary from company to company, some clear patterns emerged among the winners. Fast-track managers tend to implement a combination of the following practices, tailoring their strategy to fit the individual needs of their companies. To continue to increase profits and revenue in an uncertain business climate, they have:

- Held tight reins on inventories
- Spread risk through diversification
- Expanded international sales and operating bases
- Consolidated manufacturing and trimmed workforces
- Pruned unprofitable or extraneous businesses
- Added product lines through internal development, joint ventures or acquisitions.

In some cases, firms vastly increased their size and ELECTRONIC BUSINESS 200 ranking largely by devouring new companies and adding sales to the corporate total. Computer and video-game manufacturer Atari Corp., for example, acquired the Federated Group Inc., a consumer electronics retail chain for $64 million. It is also seeking to acquire a semiconductor facility or, at least, to form an alliance with a chip company. And West Amherst, New York-based Mark IV purchased diversified Conrac Corp., for $185 million; and the Eagle Signal Controls Division of Wickes, for $16 million. In keeping with its strategy to manufacture only proprietary products, Mark IV at the same time got rid of its Engineered Magnetics business and its polystyrene and rubber-producing plants.

Strategic fit

San Jose-based Anthem expanded to the Northeast with the purchase of distributor Lionex Corp. And Olin Corp., Stamford, Conn., bought Aegis Inc., a supplier to the hybrid microelectronics industry, while divesting its firearm manufacturing business, among others. "Focusing on profit detractors continues to be a major strategic emphasis," says John W. Johnstone Jr., president of the Stamford, Conn., electronic materials and services, metals and chemicals company. "The issue of strategic fit must be addressed. There are no sacred cows at Olin."

The stepped-up pace of mergers and acquisitions in the electronics sector is also expected to continue. Dynascan, for one, intends to each year buy a company worth more than $25 million. In 1987, it completed the acquisition of Marantz Co., transforming the faltering audio equipment maker into a profitable business. The same year, Dynascan also sold off its industrial control and test equipment operations to concentrate solely on consumer electronics.

Despite Wall Street's generally negative attitude toward consumer electronics, Dynascan believes it can be a gold mine for those with the right strategy. "It's a terrific place to grow profitably by following selective nichemanship," says Kalov. For Dynascan, that "nichemanship" means never being a pioneer and never going up against the giants. "We do not want to be first; that requires substantial investment," explains Kalov. "We prefer to watch the market develop, begin to mature and learn from the mistakes of others." Dynascan's products include Cobra brand telephones, auto radar detectors, CB radios, stereo equipment and facsimile machines.

Nichemanship

These days, nichemanship can mean the difference between winning and losing. LSI Logic Corp., Milpitas, Calif., is betting that by transforming into an application-specific integrated circuit systems supplier it will cash in on the fast-growing ASIC business in the 1990s.

Mark IV, meanwhile, has targeted small industrial markets, from $20 million to $250 million, thus enabling them to steer clear of the giants. Also, says Alfiero, "the markets we pursue have significant technical and financial thresholds which may reduce the number of small competitors." Mark IV's businesses include everything from microprocessor controls to professional sound systems to telephone answering machines.

Niches don't have to be small, off-the-beaten-track segments. ▷

Can't tell an annual report by its cover

"Changing for the future," announces Cincinnati Milacron Inc. in big, bold red letters on the somber gray cover of its 1987 annual report. NBI Inc., meanwhile, declares: "Change equals opportunity" on the front of its latest report. Indeed, for those firms whose ELECTRONIC BUSINESS 200 standing dropped dramatically last year, change is indeed the name of the game.

In face of sales downturns, troubled companies dramatically restructured operations. They shut down or sold businesses, took painful writeoffs, trimmed workforces, brought in new managers and hoped for the best. "What we did in 1987 was demonstrate our ability to change," says Gary K. Willis, president of Foxboro Inc., a Foxboro, Mass., manufacturer of process control equipment.

GenRad Inc., a Concord, Mass. producer of test and measurement systems, closed the doors of its Semiconductor Test Division, which made high-end VLSI test systems. The cost: $32.5 million. Cleveland-based Eaton Corp. started selling its defense operations. Penn Central Corp., Cincinnati maker of telecommunications, defense and energy products, spun off its Sprague Technologies Inc. electronics businesses. And BRIntec Corp. put its printed circuit board and specialty telephone equipment businesses on the block.

"Restructuring actions were initiated as a strategic response to economic, technological and competitive changes," says Peter Petruchik, president of BRIntec, a Willimantic, Conn., maker of connectors and cable. BRIntec and other survivors of painful restructuring are predicting increased sales and profits in coming years. "We expect earnings growth averaging 12% to 15% a year and return on equity exceeding 20%," predicts Petruchik.

These new, leaner companies don't intend to get caught short again. "Restructuring can never be considered an accomplished fact," says Foxboro's Willis. "It must remain a dynamic process calculated to challenge our performance on a continuing basis." He adds: "The major efforts are behind us."

Compaq Computer Corp., for example, went up against no less of a giant than IBM with commodity products — and managed to surpass $1 billion in sales and $135 million in profits after only five years. Its niche is IBM-clone computers. Indeed, Compaq has become one of the industry's most remarkable success stories by beating IBM at its own game. Houston-based Compaq offers the same technology for less money and also steps in to fill the gaps when IBM leaves a market. By the end of 1987, boasts Rod Canion, Compaq president, "we emerged as a leader in high performance, industry-standard products worldwide."

Being a global leader is increasingly important. LSI Logic's international revenue, for example, last year grew twice as fast as total corporate revenue. And, says James M. McCoy, president of Maxtor Corp., San Jose: "Strengthening our position as a leading factor in the worldwide data storage marketplace is our primary goal." In 1987, the 5-year-old high-capacity disk maker broke ground for a new facility in Singapore and opened its first international direct sales office in Britain. "Boosted particularly by growth in Western Europe, international sales reached nearly $28 million, 16% of total revenues," according to McCoy.

Global leader

Atari, meanwhile, opened sales subsidiaries in Sweden, Spain, Australia and Mexico. The formerly beleaguered electronic game manufacturer has, under the leadership of Jack Tramiel, chairman, become a respected player in international markets for a variety of computer products, software and peripherals. Even its original video game line is making a comeback. Net sales outside North America accounted for 46% of total sales in 1987.

Atari UK reportedly has secured a 40% share of the 16-bit personal computer market in Great Britain. West Germany's Supreme Court keeps track of volumes of courtroom precedents and trial verdicts on Atari equipment. And in France, jazz artist Jean Michel Jarre composes on his Atari ST, taking advantage of Atari's musical instrument digital interface ports that allow musicians to connect synthesizers and instruments to their computers. "Our commitment to an international marketing strategy has resulted in a dramatic increase in European sales," says Tramiel. In fact, he says, European demand for Atari's new personal computers rose so sharply last year the firm was forced to postpone its marketing assault in the United States.

For the ELECTRONIC BUSINESS 200 as a whole, foreign sales accounted for about 25% of total corporate sales, about the same as last year but up dramatically from 14% two years ago. In many cases, unit sales growth was higher, but losses resulting from the weak dollar in many markets shrouded real growth.

For two straight years, foreign sales accounted for 25% of the 200's total revenue

Having a worldwide base not only moves engineering and manufacturing operations closer to customers, it also enables a company to compensate for a cyclical downturn in one geographical area with sales to another, economically stronger location. "Being global makes us less vulnerable to protectionism and it shields us, in part at least, from the effect of swings in currency values," says T. Kevin Dunnigan, president of components maker Thomas & Betts Corp. "Becoming truly multinational is a complex problem, but the long-term advantages make the effort worthwhile."

Those long-term advantages will be most noticeable on a firm's bottom line. And as the electronics industry grows from the wild child of the early years to the mature industry of the 1990s, the bottom line will continue to be the most important consideration. Mark IV chairman Alfiero spoke for many successful electronics executives in outlining his firm's objectives: "Our goals are to strengthen our balance sheet, to work with our existing operations to enhance profitability and to watch for opportunities to expand and excel." □

Notes to the 200

Revenue
Revenue includes sales of products, services and rentals, but excludes dividends, interest and other nonoperating revenue.

Profit
Profits are shown after taxes from continuing operations and before extraordinary items.

Return on equity
ROE is profits as a percentage of **shareholders' equity** — preferred stock, capital stock, surplus and retained earnings at year-end.

Return on investment
ROI is profits as a percentage of shareholders' equity plus short- and long-term debt. **Short-term debt** includes the current portion of long-term debt, notes payable and other borrowings.

Cost of goods sold
This includes manufacturing costs of products, services and rentals sold, less depreciation.

Research and development
R&D is company-sponsored research and development expenses as a percentage of revenue.

Employees
The number of employees is supplied by each company. In most cases this number represents year-end employment.

Capital expenditures to net cash flow
Capital expenditures are measured as a percentage of net profits plus depreciation, minus cash dividends paid.

Debt to total capital
This includes long-term debt plus short-term debt as a percentage of shareholders' equity and long- and short-term debt.

Foreign sales
These include sales of operations outside the United States to unaffiliated customers and U.S. operations' export sales.

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES

Ranking: 1 - 50

Rank 1987	Rank 1986	Company	Calendar year 1987: Electronics revenue ($ millions)	Calendar year 1987: Total revenue ($ millions)	Calendar year 1987: Net income ($ millions)	Fiscal year 1987: Total revenue ($ millions)	Fiscal year 1987: Net income ($ millions)	Return on equity	Return on investment
1	1	**IBM**	$54,217.0	$54,217.0	$5,258.0	$54,217.0	$5,258.0	13.7%	12.0%
2	2	**AT&T**	16,062.0	33,598.0	2,044.0	33,598.0	2,044.0	14.1%	9.1%
3	4	**GM Hughes Electronics**	10,481.0	10,481.0	521.1	10,481.0	521.1	7.4%	6.7%
4	5	**Digital Equipment**	10,391.1	10,391.1	1,284.2	9,389.4	1,137.4	18.1%	17.3%
5	7	**Unisys**	9,712.9	9,712.9	578.0	9,712.9	578.0	12.7%	8.7%
6	3	**General Electric**	9,514.0	39,315.0	2,915.0	39,315.0	2,119.0	12.9%	9.6%
7	6	**Xerox**	8,980.0	10,320.0	578.0	10,320.0	578.0	10.4%	7.5%
8	8	**Hewlett-Packard**	8,542.0	8,542.0	707.0	8,090.0	644.0	12.8%	10.6%
9	11	**Motorola**	6,707.0	6,707.0	308.0	6,707.0	308.0	10.2%	8.3%
10	12	**Honeywell**	6,679.3	6,679.3	253.7	6,679.3	253.7	11.3%	7.0%
11	14	**NCR**	5,640.7	5,640.7	419.3	5,640.7	419.3	19.4%	17.7%
12	13	**Texas Instruments**	5,594.5	5,594.5	256.9	5,594.5	256.9	11.4%	9.2%
13	10	**Lockheed**	5,241.6	11,321.0	436.0	11,321.0	436.0	20.9%	7.2%
14	15	**Raytheon**	4,740.0	7,659.4	445.1	7,659.4	445.1	24.1%	19.0%
15	17	**Eastman Kodak**	4,435.0	13,305.0	1,178.0	13,305.0	1,178.0	19.6%	14.3%
16	16	**Rockwell International**	4,423.7	11,936.5	678.6	12,123.4	635.1	19.2%	15.0%
17	19	**Tandy**	3,654.7	3,654.7	289.8	3,452.2	242.3	17.6%	15.3%
18	9	**Allied-Signal**	3,380.0	11,116.0	515.0	11,116.0	515.0	16.5%	9.1%
19	20	**TRW**	3,192.0	6,821.0	243.0	6,821.0	243.0	17.1%	9.4%
20	23	**Litton Industries**	3,191.7	4,735.5	151.3	4,419.7	138.1	13.1%	10.8%
21	22	**Wang Laboratories**	3,047.6	3,047.6	94.5	2,836.7	70.7	4.8%	3.1%
22	31	**Apple Computer**	3,041.3	3,041.3	280.4	2,661.1	217.5	26.0%	26.0%
23	28	**Martin Marietta**	2,960.2	5,165.1	230.7	5,165.1	230.7	25.4%	18.3%
24	26	**Ford Motor**	2,786.9	71,643.4	4,625.2	71,643.4	4,625.2	25.1%	21.0%
25	25	**3M**	2,698.0	9,429.0	918.0	9,429.0	918.0	18.1%	15.9%
26	21	**Control Data**	2,667.5	3,366.5	21.5	3,366.5	25.0	2.4%	1.7%
27	27	**ITT**	2,662.6	19,525.0	1,018.0	8,551.0	1,018.1	13.0%	9.5%
28	24	**Westinghouse Electric**	2,563.0	10,679.0	738.9	10,679.0	738.9	20.7%	12.4%
29	34	**Zenith Electronics**	2,362.7	2,362.7	-19.1	2,362.7	-19.1	-4.0%	-2.1%
30	29	**Harris**	2,100.1	2,100.1	92.2	2,079.0	84.5	8.6%	7.4%
31	36	**Pitney Bowes**	2,009.2	2,250.5	199.4	2,250.5	199.4	19.2%	13.5%
32	37	**Du Pont**	2,000.0	30,468.0	1,786.0	30,468.0	1,786.0	12.5%	9.4%
33	33	**Boeing**	1,980.0	15,355.0	480.0	15,355.0	480.0	9.6%	9.1%
34	40	**AMP**	1,912.0	2,317.8	249.7	2,317.8	249.7	18.5%	16.3%
35	48	**Intel**	1,907.1	1,907.1	175.5	1,907.1	175.5	13.4%	8.5%
36	39	**National Semiconductor**	1,877.7	1,877.7	-28.8	1,867.9	-28.8	-3.2%	-2.9%
37	38	**McDonnell Douglas**	1,810.0	13,344.5	313.0	13,344.5	313.0	10.5%	6.9%
38	32	**GTE**	1,784.2	15,421.0	1,118.8	15,421.0	1,082.0	11.3%	5.4%
39	45	**Emerson Electric**	1,770.0	6,317.5	482.8	6,170.3	467.2	17.3%	12.9%
40	41	**Singer**	1,618.0	1,902.7	23.4	1,902.7	23.4	3.7%	1.5%
41	52	**Amdahl**	1,505.2	1,505.2	142.0	1,505.2	142.0	18.[illegible]	15.4%
42	47	**Avnet**	1,482.0	1,670.7	37.3	1,547.1	22.8	3.5%	2.6%
43	42	**United Technologies**	1,420.0	17,170.2	591.7	17,170.2	591.7	10.3%	7.2%
44	44	**Tektronix**	1,388.9	1,388.9	25.7	1,395.9	51.2	6.1%	5.7%
45	46	**Data General**	1,303.9	1,303.9	-75.9	1,274.3	-82.9	-14.1%	-11.7%
46	50	**Perkin-Elmer**	1,233.0	1,377.8	-9.6	1,333.6	-18.2	-2.6%	-2.0%
47	69	**Compaq Computer**	1,224.1	1,224.1	136.3	1,224.1	136.3	34.1%	24.8%
48	43	**Teledyne**	1,222.0	3,216.8	377.2	3,216.8	377.2	19.1%	14.9%
49	49	**Northrop**	1,124.5	6,052.5	94.2	6,052.5	94.2	9.9%	5.0%
50	57	**General Instrument**	1,104.0	1,104.0	53.6	787.9	18.5	4.0%	2.8%

NA = not available NM = not meaningful

	Fiscal year 1987			Five-year growth (Compounded average annual growth rate)					
Cost of goods as a percentage of revenue	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income	Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
38.9%	10.0%	$139.3	$13.5	9.5%	3.6%	70.2%	12.5%	54.0%	12/87
38.2%	7.3%	110.9	6.7	NA	NA	82.3%	35.2%	NA	12/87
72.3%	4.0%	104.8	5.2	NA	NA	56.1%	9.7%	11.6%	12/87
22.3%	10.8%	85.0	10.3	19.3%	22.2%	47.6%	4.2%	47.0%	6/87
32.5%	6.1%	105.0	6.2	18.9%	33.4%	75.4%	31.6%	43.6%	12/87
71.5%	3.1%	130.2	7.0	7.7%	3.4%	71.5%	25.4%	23.4%	12/87
45.1%	7.0%	104.2	5.8	5.3%	47.8%	97.3%	27.9%	44.9%	12/87
42.6%	11.1%	98.7	7.9	14.1%	11.0%	54.8%	17.5%	49.0%	10/87
53.2%	7.8%	68.6	3.2	12.1%	12.6%	91.5%	19.4%	43.8%	12/87
66.8%	4.3%	84.7	3.2	11.3%	6.6%	53.0%	38.4%	20.6%	12/87
48.8%	6.3%	91.0	6.8	9.9%	12.4%	62.4%	9.0%	54.6%	12/87
71.5%	7.7%	71.7	3.3	5.3%	12.3%	82.0%	19.7%	31.5%	12/87
89.7%	4.8%	114.0	4.4	15.1%	16.1%	53.9%	65.5%	8.0%	12/87
76.9%	3.5%	100.1	5.8	8.0%	8.0%	64.6%	21.1%	17.1%	12/87
52.7%	7.5%	107.0	9.5	4.2%	0.3%	103.2%	26.9%	42.8%	12/87
74.8%	3.5%	104.4	5.5	10.4%	13.9%	50.2%	21.6%	15.1%	9/87
47.4%	0.0%	88.5	6.2	13.5%	1.6%	34.3%	12.6%	1.6%	6/87
77.0%	6.0%	96.4	4.5	17.8%	12.9%	108.6%	44.6%	19.3%	12/87
73.1%	4.8%	87.6	3.1	8.9%	7.4%	100.0%	45.4%	25.7%	12/87
76.1%	4.7%	81.5	2.5	2.1%	-14.0%	84.7%	17.7%	22.7%	7/87
27.1%	7.5%	93.6	2.3	19.6%	-8.0%	42.8%	33.8%	40.1%	6/87
46.1%	7.2%	475.2	38.8	35.5%	28.8%	31.6%	0.0%	27.1%	9/87
76.5%	4.3%	73.8	3.3	11.2%	16.9%	77.9%	27.9%	NA	12/87
77.2%	3.5%	204.5	13.2	14.1%	NM	51.7%	16.5%	NA	12/87
52.5%	6.6%	115.0	11.2	7.4%	7.8%	77.9%	12.1%	39.8%	12/87
63.3%	11.6%	97.6	0.7	1.1%	-30.6%	73.8%	29.6%	20.0%	12/87
77.4%	2.2%	71.3	8.5	-11.7%	7.7%	37.2%	27.2%	52.4%	12/87
70.3%	2.0%	94.9	6.6	1.8%	10.5%	51.0%	39.8%	20.6%	12/87
83.7%	4.4%	67.5	-0.5	13.8%	NM	247.3%	47.7%	17.2%	12/87
58.8%	5.7%	85.6	3.5	4.8%	1.1%	39.7%	13.8%	14.7%	6/87
31.7%	2.9%	76.4	6.8	10.0%	17.5%	88.9%	29.5%	19.5%	12/87
49.0%	4.0%	217.4	12.7	1.0%	14.8%	100.1%	25.0%	49.8%	12/87
84.8%	5.4%	112.8	3.5	11.2%	10.5%	96.2%	5.1%	40.9%	12/87
56.8%	8.8%	105.4	11.3	13.3%	16.0%	57.6%	12.2%	52.3%	12/87
45.7%	13.6%	99.3	9.1	16.2%	42.4%	86.9%	36.5%	38.8%	12/87
62.1%	11.7%	64.0	-1.0	11.1%	NM	79.2%	11.3%	42.1%	5/87
76.7%	4.9%	118.7	2.8	12.5%	7.8%	86.9%	34.9%	21.4%	12/87
41.3%	1.6%	95.8	6.7	6.0%	5.9%	116.4%	52.1%	13.3%	12/87
62.8%	3.1%	89.8	6.8	10.1%	7.6%	29.3%	25.3%	20.0%	9/87
92.2%	2.0%	68.0	0.8	9.0%	-18.6%	109.5%	60.0%	NA	12/87
47.8%	11.9%	198.0	18.7	26.6%	96.1%	66.2%	17.1%	44.3%	12/87
73.5%	0.0%	162.8	2.4	6.8%	-16.5%	146.5%	25.7%	NA	6/87
73.2%	5.1%	90.4	3.1	6.5%	5.3%	156.2%	29.4%	24.5%	12/87
39.8%	14.3%	81.6	3.0	3.1%	-6.7%	49.5%	6.0%	42.2%	5/87
47.8%	12.5%	81.2	-5.3	9.6%	NM	576.1%	16.8%	45.0%	9/87
52.6%	10.5%	94.5	-1.3	5.2%	NM	492.2%	22.8%	46.2%	7/87
56.8%	3.8%	306.0	34.1	NA	NA	71.4%	27.2%	26.0%	12/87
73.5%	2.7%	72.5	8.5	-3.6%	6.9%	19.2%	21.8%	7.9%	12/87
94.4%	2.7%	125.6	2.0	19.6%	79.9%	103.4%	49.3%	NA	12/87
76.5%	3.1%	48.3	1.1	-2.9%	-28.1%	103.7%	29.4%	16.2%	2/87

Source: ELECTRONIC BUSINESS

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES

Ranking: 51-100

Rank 1987	Rank 1986	Company	Calendar year 1987			Fiscal year 1987		Return on equity	Return on investment
			Electronics revenue ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Total revenue ($ millions)	Net income ($ millions)		
51	53 *	**Grumman**	$1,089.5	$3,375.3	$27.1	$3,375.3	$27.1	1.8%	1.2%
52	60	**Tandem Computers**	1,079.7	1,079.7	102.2	1,035.5	105.6	14.6%	14.4%
53	66	**Seagate Technology**	1,075.7	1,075.7	115.3	958.1	139.7	39.5%	21.3%
54	51	**E-Systems**	1,067.2	1,227.2	60.4	1,227.2	60.4	14.1%	11.8%
55	55	**General Dynamics**	1,050.0	9,344.0	437.3	9,344.0	437.3	27.3%	21.6%
56	56	**Varian Associates**	1,032.9	1,032.9	-4.1	982.8	21.4	4.9%	4.1%
57	71	**Advanced Micro Devices**	997.1	997.1	-48.1	997.1	-48.1	-7.3%	-6.0%
58	58	**Prime Computer**	960.9	960.9	64.8	960.9	64.8	12.9%	6.1%
59	59	**Chrysler**	946.0	26,276.5	1,289.7	26,276.5	1,289.7	19.8%	12.7%
60	53	**Gould**	933.4	933.4	25.0	933.4	25.0	5.2%	3.0%
61	68	**Loral**	920.0	1,244.7	69.6	690.0	57.5	15.8%	13.6%
62	61	**Johnson Controls**	811.0	2,806.8	96.6	2,676.8	89.6	11.6%	8.2%
63	63	**Emerson Radio**	792.4	792.4	-9.8	810.1	26.6	27.7%	9.0%
64	35	**Eaton**	775.0	3,137.9	206.2	3,137.9	206.2	19.2%	10.8%
65	93	**Sun Microsystems**	755.9	755.9	48.0	537.5	36.3	15.1%	9.0%
66	67	**Storage Technology**	750.0	750.0	19.0	750.0	19.0	8.1%	3.1%
67	70	**SmithKline Beckman**	704.1	4,328.8	570.1	4,328.8	570.1	36.0%	20.4%
68	73	**Cray Research**	687.3	687.3	147.1	687.3	147.1	24.1%	20.2%
69	54	**Contel**	660.0	2,905.5	77.7	2,905.5	77.7	5.4%	2.1%
70	64	**General Signal**	641.2	1,603.0	69.4	1,603.0	69.4	7.6%	6.8%
71	72	**Intergraph**	641.1	641.1	69.9	641.1	69.9	12.3%	12.2%
72	77	**Monsanto**	634.0	7,639.0	436.0	7,639.0	436.0	11.2%	7.3%
73	80	**SCI Systems**	614.7	614.7	17.0	552.9	16.0	12.0%	5.0%
74	—	**Computer Associates**	604.7	604.7	79.2	309.3	36.5	16.6%	11.1%
75	79	**Computervision** [1]	564.0	564.0	19.5	564.0	19.5	NA	NA
76	89	**Western Digital**	563.1	563.1	44.5	462.5	42.8	21.2%	20.3%
77	78	**Arrow Electronics**	562.4	562.4	-15.8	562.4	-15.8	-16.4%	-10.0%
78	86	**Apollo Computer**	553.7	553.7	21.7	553.7	21.7	9.6%	6.3%
79	85	**Medtronic**	537.0	608.0	83.5	502.0	73.8	19.1%	17.4%
80	74	**Corning Glass Works**	522.0	2,083.7	203.3	2,083.7	203.3	13.2%	10.3%
81	81	**Scientific-Atlanta**	513.9	513.9	28.4	495.3	24.3	12.0%	11.6%
82	115	**Atari**	493.2	493.2	44.2	493.2	44.2	26.3%	14.2%
83	82	**United Telecommunications**	476.3	2,982.2	-51.5	2,982.2	-51.5	-3.3%	-1.1%
84	88	**Tyler**	475.4	1,099.5	16.8	1,099.5	16.8	9.4%	5.8%
85	84	**Xidex**	460.0	579.7	-9.2	572.8	-44.5	-11.5%	-8.4%
86	114	**Microsoft**	456.7	456.7	92.9	345.9	71.9	30.1%	29.2%
87	—	**Raychem**	447.2	1,016.4	89.8	944.4	73.6	12.9%	10.5%
88	75	**M/A-COM**	437.3	437.3	-27.3	436.1	-29.3	-10.9%	-7.5%
89	—	**Sprague Technologies**	437.3	437.3	3.6	437.3	3.6	1.1%	1.0%
90	91	**Molex**	437.1	437.1	50.2	386.8	43.4	13.7%	13.3%
91	96	**EG&G**	420.4	1,247.5	55.5	1,247.5	55.5	20.4%	15.7%
92	83	**Textron**	410.0	5,388.4	261.1	5,388.4	261.1	11.3%	6.9%
93	116	**LTV**	396.0	7,581.8	502.6	7,581.8	502.6	-24.6%	-25.0%
94	106	**Lotus Development**	395.6	395.6	72.0	395.6	72.0	35.7%	30.0%
95	131	**Wyse Technology**	392.8	392.8	25.4	260.0	18.1	19.6%	18.2%
96	119	**Emhart**	392.0	2,454.5	106.5	2,454.5	106.5	12.7%	7.6%
97	95	**Analog Devices**	390.7	390.7	22.3	370.4	18.7	6.1%	5.6%
98	101	**Convergent**	384.8	384.8	-26.5	384.8	-26.5	-13.7%	-12.3%
99	100	**Teradyne**	377.7	377.7	-21.5	377.7	-21.5	-7.7%	-6.5%
100	92	**Compugraphic**	367.1	367.1	10.1	367.1	10.1	5.1%	4.0%

* 1986 rank readjusted

NA = not available

[1] bought by Prime Feb. 12, 1988

NM = not meaningful

Cost of goods as a percentage of revenue	Fiscal year 1987			Five-year growth (Compounded average annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income				
89.4%	1.4%	$100.2	$0.8	10.4%	-21.4%	187.8%	34.2%	9.3%	12/87
29.6%	10.5%	147.8	15.1	27.1%	0.0%	90.3%	1.4%	44.4%	9/87
68.6%	3.5%	59.9	8.7	88.3%	82.5%	46.8%	46.1%	43.6%	6/87
81.4%	2.7%	79.1	3.9	11.8%	8.2%	68.3%	16.1%	6.6%	12/87
78.9%	3.6%	88.7	4.2	9.7%	20.7%	48.9%	21.1%	NA	12/87
65.0%	8.2%	82.6	1.8	8.4%	-3.0%	87.3%	16.6%	23.6%	9/87
41.1%	24.9%	55.3	-2.7	19.5%	NM	141.8%	17.7%	27.2%	12/87
38.2%	11.4%	109.0	7.3	17.1%	7.6%	69.0%	52.3%	48.0%	12/87
77.7%	3.0%	186.4	9.1	21.2%	NM	65.8%	35.8%	9.9%	12/87
49.4%	10.1%	92.2	2.5	4.0%	-17.2%	51.2%	42.2%	38.0%	12/87
73.9%	4.6%	47.6	4.0	19.6%	17.2%	45.9%	13.9%	6.2%	3/87
76.4%	1.8%	99.5	3.3	16.4%	10.7%	70.0%	29.6%	14.4%	9/87
88.1%	0.1%	1,012.6	33.3	56.0%	145.2%	14.6%	67.4%	NA	3/87
68.0%	3.7%	87.4	5.7	7.2%	NM	58.6%	43.6%	22.7%	12/87
46.1%	12.9%	128.5	8.7	474.4%	NM	124.0%	40.5%	32.0%	6/87
59.5%	8.0%	84.6	2.1	-7.0%	-21.8%	183.5%	61.7%	26.4%	12/87
31.0%	9.8%	119.2	15.7	10.4%	4.6%	29.6%	43.3%	38.1%	12/87
11.4%	15.8%	159.5	34.1	37.2%	50.6%	18.3%	16.1%	37.0%	12/87
30.2%	0.0%	133.8	3.6	8.0%	-11.3%	173.6%	60.8%	NA	12/87
61.3%	6.6%	83.8	3.6	-0.2%	-8.4%	42.1%	11.5%	20.9%	12/87
45.1%	10.5%	101.8	11.1	32.7%	40.0%	44.8%	1.0%	36.9%	12/87
53.4%	8.1%	153.6	8.8	3.8%	5.8%	55.9%	35.0%	NA	12/87
93.0%	0.0%	83.0	2.4	43.8%	31.3%	104.8%	58.3%	24.8%	6/87
-8.8%	13.0%	114.6	13.5	48.3%	65.8%	16.4%	32.8%	48.7%	3/87
NA	NA	NA	NA	11.6%	-9.7%	NA	NA	NA	12/87
59.3%	8.1%	138.5	12.8	69.2%	43.2%	66.7%	4.1%	36.9%	6/87
79.4%	0.0%	308.0	-8.7	5.8%	NM	-13.0%	39.5%	0.0%	12/87
44.5%	11.0%	138.4	5.4	98.2%	135.4%	84.3%	34.2%	51.8%	12/87
28.4%	8.4%	101.4	14.9	11.9%	8.7%	32.3%	8.8%	41.5%	4/87
60.6%	4.8%	81.7	8.0	5.7%	22.2%	76.6%	22.3%	31.3%	12/87
69.0%	4.1%	147.9	7.2	8.0%	11.4%	18.9%	3.5%	0.2%	6/87
60.8%	3.7%	120.6	10.8	19.1%	16.2%	8.4%	46.2%	45.9%	12/87
-18.9%	0.0%	127.9	-2.2	4.3%	NM	218.9%	67.1%	NA	12/87
74.8%	0.0%	146.6	2.2	11.0%	13.0%	76.5%	38.4%	NA	12/87
76.7%	2.0%	83.0	-6.5	42.6%	NM	-150.0%	26.7%	29.9%	6/87
19.2%	11.0%	190.5	39.6	69.8%	83.0%	73.0%	2.9%	42.3%	6/87
42.0%	7.3%	95.4	7.4	12.0%	14.6%	65.7%	18.8%	61.6%	6/87
69.0%	5.6%	64.6	-4.3	4.5%	NM	-295.1%	31.4%	21.5%	9/87
74.1%	4.8%	50.8	0.4	NA	NA	76.2%	5.1%	38.2%	12/87
46.2%	5.5%	77.9	8.7	18.4%	16.0%	65.2%	3.3%	68.4%	6/87
78.9%	1.4%	55.4	2.5	8.3%	6.9%	29.8%	22.9%	7.1%	12/87
78.5%	2.2%	88.3	4.3	22.1%	30.6%	65.3%	39.2%	27.5%	12/87
81.7%	0.0%	157.3	10.4	9.7%	26.5%	45.7%	-1.5%	NA	12/87
13.4%	14.8%	188.4	34.3	356.3%	NM	30.3%	15.7%	52.3%	12/87
66.4%	5.3%	128.7	9.0	102.7%	NM	36.8%	7.5%	0.2%	3/87
64.5%	1.6%	8.0	3.5	7.5%	5.8%	64.7%	40.2%	40.9%	12/87
37.3%	15.1%	71.2	3.6	16.3%	13.6%	82.1%	8.3%	0.5%	10/87
59.1%	8.7%	114.9	-7.9	24.8%	NM	-600.3%	10.2%	17.0%	12/87
50.2%	16.3%	80.4	-4.6	12.8%	NM	374.1%	15.9%	36.4%	12/87
49.0%	10.9%	88.7	2.4	5.6%	4.5%	90.3%	20.7%	28.9%	12/87

Source: ELECTRONIC BUSINESS

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES

Ranking: 101-150

Rank 1987	Rank 1986	Company	Calendar year 1987 Electronics revenue ($ millions)	Calendar year 1987 Total revenue ($ millions)	Calendar year 1987 Net income ($ millions)	Fiscal year 1987 Total revenue ($ millions)	Fiscal year 1987 Net income ($ millions)	Return on equity	Return on investment
101	158	**MiniScribe**	$362.5	$362.5	$28.1	$362.5	$28.1	27.8%	14.0%
102	111	**Dover**	360.6	1,585.5	111.7	1,585.5	111.7	16.6%	13.1%
103	94	**Diebold**	360.0	439.1	35.8	439.1	35.8	10.5%	10.3%
104	105	**Dynatech**	348.9	348.9	21.4	304.7	23.2	16.8%	13.9%
105	—	**LPL Investment**[2]	347.3	347.3	5.1	347.3	5.1	13.5%	0.9%
106	99	**AM International**	342.0	1,199.0	1.6	1,162.8	2.3	0.9%	0.4%
107	120	**Nashua**	341.0	865.1	26.6	865.1	26.6	12.8%	9.5%
108	109	**Marshall Industries**	340.3	340.3	10.6	286.6	5.1	9.4%	5.1%
109	—	**MAI Basic Four**	334.3	334.3	23.8	321.0	22.8	29.3%	17.6%
110	90	**Dataproducts**	334.2	334.2	-3.6	338.8	9.0	4.1%	3.3%
111	126	**Polaroid**	330.0	1,763.9	116.1	1,763.9	116.1	10.8%	8.9%
112	65	**Penn Central**	325.0	1,421.4	34.8	1,421.4	34.8	2.1%	1.9%
113	98	**Datapoint**	320.7	320.7	15.1	312.1	-58.5	-32.2%	-20.1%
114	113	**Augat**	313.2	313.2	11.5	313.2	11.5	5.4%	4.8%
115	102	**DSC Communications**	312.4	312.4	14.6	312.4	14.6	6.9%	5.1%
116	180	**Mark IV Industries**	311.2	394.9	16.2	291.5	10.2	25.3%	3.9%
117	97	**Cubic**	311.0	357.8	7.7	361.8	7.9	7.1%	4.1%
118	123	**Eli Lilly**	308.0	3,643.8	410.5	3,643.8	410.5	13.5%	11.3%
119	174	**Genicom**	302.2	302.2	12.6	302.2	12.6	21.5%	7.5%
120	110	**Premier Industrial**	296.0	486.8	56.0	459.0	48.3	18.1%	17.6%
121	—	**Westmark International**	291.9	291.9	-7.2	291.9	-7.2	-3.2%	-3.1%
122	168	**AST Research**	289.8	289.8	8.3	206.0	13.0	13.1%	13.1%
123	127	**Tandon**	289.1	289.1	17.1	289.1	17.1	18.3%	15.2%
124	138	**Micropolis**	288.3	288.3	27.2	288.3	27.2	19.6%	12.7%
125	148	**Bolt Beranek and Newman**	279.8	279.8	-6.1	233.8	-8.0	-9.4%	-8.7%
126	149	**AVX**	271.9	271.9	15.8	271.9	15.8	8.5%	4.8%
127	121	**Square D**	270.5	1,484.2	110.0	1,484.2	110.0	16.2%	12.4%
128	103	**TIE/communications**	270.2	270.2	-11.1	250.2	-11.1	-6.4%	-5.1%
129	124	**Recognition Equipment**	269.2	269.2	10.1	264.7	11.2	8.4%	5.6%
130	136	**Diasonics**	267.6	267.6	15.2	267.6	15.2	14.4%	12.1%
131	104	**Foxboro**	267.3	504.4	-96.9	504.4	-96.9	-51.5%	-40.1%
132	141	**Ashton-Tate**	267.3	267.3	43.1	267.3	43.1	24.1%	23.0%
133	108	**Savin**	267.2	356.3	115.0	356.3	0.1	-0.2%	0.1%
134	129	**Figgie International**	266.0	1,022.7	49.3	1,022.7	49.3	15.3%	11.0%
135	134	**Wyle Laboratories**	265.4	368.0	5.8	368.0	5.8	6.5%	4.3%
136	118	**Watkins-Johnson**	264.3	264.3	17.1	264.3	17.1	14.7%	12.0%
137	151	**LSI Logic**	262.1	262.1	10.7	262.1	10.7	3.5%	2.2%
138	125	**CTS**	261.1	261.1	10.5	261.1	10.5	8.3%	6.3%
139	107	**Kollmorgen**	260.0	301.0	0.3	301.0	0.3	0.4%	0.2%
140	117	**Bally Manufacturing**	255.0	1,730.1	-6.4	1,730.1	-6.4	-1.1%	-0.3%
141	139	**Gerber Scientific**	254.8	254.8	28.0	223.9	21.1	13.1%	11.7%
142	133	**Cooper Industries**	251.0	3,585.8	173.8	3,585.8	173.8	10.9%	6.8%
143	153	**Bell Industries**	250.0	407.1	4.5	357.1	3.3	3.1%	2.4%
144	157	**Ball**	242.2	1,054.1	66.3	1,054.1	66.3	16.7%	12.2%
145	184	**Maxtor**	239.4	239.4	16.1	175.3	22.4	22.0%	10.7%
146	137	**Pioneer-Standard**	238.5	238.5	4.1	212.2	1.8	6.3%	2.2%
147	194	**Applied Magnetics**	235.7	235.7	17.5	211.9	14.2	9.5%	9.2%
148	132	**Reynolds & Reynolds**	234.0	572.1	19.5	562.7	21.2	11.0%	7.1%
149	112	**Paradyne**	232.6	232.6	-2.6	232.6	-2.6	-1.8%	-1.1%
150	147	**Andrew**	229.0	229.0	4.2	223.2	3.8	2.5%	2.2%

[2] acquired Amphenol Corp. from Allied Signal on June 2, 1987

NA = not available NM = not meaningful

	Fiscal year 1987			Five-year growth (Compounded average annual growth rate)					
Cost of goods as a percentage of revenue	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income	Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
71.3%	5.5%	$72.9	$5.7	135.5%	NM	28.2%	49.6%	36.1%	12/87
65.2%	2.9%	90.1	6.3	8.9%	4.5%	28.8%	21.1%	24.0%	12/87
64.6%	3.3%	90.0	7.3	0.5%	-2.9%	29.7%	2.0%	7.0%	12/87
40.8%	9.0%	98.3	7.5	23.7%	30.2%	37.3%	26.3%	25.4%	3/87
59.3%	2.1%	NA	NA	NA	NA	3.4%	93.3%	24.4%	12/87
63.8%	4.2%	97.3	0.2	14.1%	NM	92.9%	54.8%	38.0%	7/87
64.9%	0.8%	128.8	4.0	7.7%	NM	67.0%	26.0%	0.5%	12/87
75.1%	0.0%	260.6	4.7	19.4%	NM	143.7%	45.7%	NA	5/87
44.6%	4.0%	98.7	7.0	5.1%	NM	47.6%	39.9%	64.1%	9/87
64.5%	6.6%	86.9	2.3	3.2%	13.8%	60.2%	19.3%	26.8%	3/87
49.9%	8.1%	129.1	8.5	6.4%	37.6%	75.4%	17.2%	42.8%	12/87
80.2%	0.7%	90.5	2.2	-14.8%	-23.3%	41.7%	10.7%	17.6%	12/87
57.8%	6.2%	113.5	-21.3	-9.3%	NM	-74.1%	37.4%	79.2%	7/87
68.1%	5.1%	82.4	3.0	8.8%	-11.2%	136.0%	11.5%	18.0%	12/87
49.6%	13.1%	122.8	5.7	35.5%	16.8%	53.5%	26.8%	14.4%	12/87
52.3%	2.2%	58.3	2.0	67.5%	70.9%	31.2%	84.7%	10.6%	2/87
73.4%	1.4%	80.4	1.8	4.3%	-13.3%	118.8%	41.9%	NA	9/87
30.7%	12.8%	141.8	16.0	4.2%	-0.1%	108.8%	16.6%	35.9%	12/87
64.8%	4.9%	84.2	3.5	NA	NA	37.8%	65.1%	32.0%	12/87
51.5%	0.6%	120.8	12.7	6.7%	6.9%	10.7%	2.5%	0.0%	5/87
55.6%	9.6%	96.6	-2.4	NA	NA	366.7%	2.7%	28.0%	12/87
56.1%	5.4%	151.7	9.6	249.5%	NM	35.0%	0.0%	19.6%	6/87
70.4%	3.6%	82.4	4.9	13.9%	1.7%	52.2%	16.8%	75.0%	12/87
72.7%	7.5%	120.9	11.4	54.3%	206.9%	52.0%	35.0%	69.7%	12/87
52.8%	6.1%	87.6	-3.0	27.6%	NM	489.1%	7.5%	NA	6/87
66.0%	3.1%	36.3	2.1	17.7%	38.8%	91.9%	43.9%	43.0%	12/87
60.8%	3.0%	75.0	5.6	7.9%	8.9%	37.3%	23.4%	19.0%	12/87
66.7%	8.6%	166.8	-7.4	7.8%	NM	-187.6%	20.3%	30.3%	12/87
53.5%	4.4%	90.7	3.8	18.7%	NM	96.6%	33.1%	49.1%	10/87
58.4%	6.9%	177.2	10.1	19.5%	10.8%	33.8%	16.4%	3.1%	12/87
60.7%	10.0%	72.1	-13.8	-3.5%	NM	-45.2%	22.1%	52.8%	12/87
11.6%	10.5%	213.9	34.5	60.8%	74.0%	11.2%	4.2%	30.3%	1/88
57.8%	1.3%	176.4	0.1	-4.2%	NM	4.5%	159.7%	10.8%	12/87
72.8%	1.3%	62.4	3.0	8.7%	14.1%	42.8%	27.9%	NA	12/87
76.7%	0.0%	169.5	2.7	13.4%	NM	49.1%	33.5%	NA	1/88
58.7%	6.4%	84.4	5.5	11.1%	10.7%	47.0%	18.2%	19.0%	12/87
48.7%	11.0%	113.0	4.6	120.8%	NM	339.5%	38.3%	14.6%	12/87
75.5%	2.0%	39.3	1.6	4.7%	3.8%	63.7%	24.3%	19.7%	12/87
66.9%	4.7%	77.2	0.1	4.4%	-50.6%	124.2%	45.6%	11.4%	12/87
61.6%	0.9%	58.8	-0.2	6.1%	NM	168.1%	71.2%	NA	12/87
46.8%	7.4%	124.4	11.7	14.2%	44.0%	41.4%	10.3%	47.0%	4/87
64.0%	0.0%	83.0	4.0	8.4%	5.2%	44.6%	37.3%	20.6%	12/87
75.0%	0.0%	155.3	1.4	11.8%	-15.3%	87.4%	23.0%	NA	6/87
77.5%	1.3%	152.8	9.6	3.4%	13.9%	153.5%	27.1%	NA	12/87
61.9%	6.7%	90.9	11.6	NA	NA	66.1%	51.6%	16.0%	3/87
75.3%	0.0%	253.6	2.2	17.5%	-4.4%	61.5%	65.0%	NA	3/87
64.9%	9.2%	30.5	2.0	18.0%	9.8%	98.8%	3.2%	46.5%	9/87
54.2%	2.2%	98.7	3.7	20.6%	22.1%	98.0%	35.4%	6.8%	9/87
53.0%	8.2%	74.7	-0.8	2.3%	NM	52.0%	37.0%	17.9%	12/87
63.1%	4.7%	97.0	1.7	9.4%	-23.3%	70.3%	13.8%	40.7%	9/87

Source: ELECTRONIC BUSINESS

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES

Ranking: 151-200

Rank 1987	Rank 1986	Company	Calendar year 1987: Electronics revenue ($ millions)	Calendar year 1987: Total revenue ($ millions)	Calendar year 1987: Net income ($ millions)	Fiscal year 1987: Total revenue ($ millions)	Fiscal year 1987: Net income ($ millions)	Return on equity	Return on investment
151	135	**Sundstrand**	$228.0	$1,365.5	$34.6	$1,365.5	$34.6	5.8%	3.7%
152	152	**Measurex**	227.4	227.4	26.8	227.4	26.8	15.8%	15.2%
153	130	**BRIntec**	222.2	293.7	5.9	293.7	5.9	10.0%	4.0%
154	164	**Mentor Graphics**	221.8	221.8	20.3	221.8	20.3	10.8%	10.5%
155	144	**Avantek**	213.7	213.7	11.6	213.7	11.6	7.5%	7.5%
156	—	**Cullinet Software**	213.4	213.4	-30.6	174.9	-27.6	-23.2%	-20.3%
157	154	**Micom Systems**	211.5	211.5	9.3	196.7	12.2	7.1%	6.8%
158	145	**Logicon**	211.4	211.4	6.5	204.8	6.1	10.5%	10.5%
159	166	**Veeco Instruments**	211.1	211.1	9.8	195.6	9.2	9.2%	6.2%
160	—	**Everex Systems**	210.1	210.1	10.2	157.5	8.6	11.7%	11.2%
161	143	**Fluke**	206.7	206.7	2.3	206.3	2.0	1.9%	1.7%
162	178	**Applied Materials**	202.3	202.3	7.5	174.4	0.3	0.2%	0.2%
163	172	**Ultimate**	201.1	201.1	17.4	172.9	13.8	15.5%	14.5%
164	176	**Digital Communications**	200.6	200.6	34.2	181.4	27.0	17.2%	17.2%
165	128	**Cincinnati Milacron**	200.0	828.0	-80.0	828.0	-80.0	-37.2%	-19.4%
166	198	**Anthem Electronics**	196.9	196.9	5.0	196.9	5.0	7.3%	6.7%
167	—	**Imo Delaval**	196.7	368.5	20.1	368.5	18.7	9.0%	4.0%
168	155	**Bell & Howell**	195.0	726.9	21.0	726.9	21.0	7.7%	4.6%
169	146	**GenRad**	193.8	193.8	2.1	193.8	2.1	2.9%	1.4%
170	156	**General DataComm**	192.6	192.6	-8.3	200.6	0.8	0.9%	0.7%
171	179	**Esterline**	192.0	270.4	-28.0	259.7	-29.3	-39.1%	-21.6%
172	183	**Dynascan**	191.6	191.6	6.6	191.6	6.6	14.5%	9.1%
173	150	**Decision Industries** [3]	191.4	191.4	-23.3	191.4	-20.4	-28.0%	-27.8%
174	199	**Olin**	190.0	1,930.0	78.0	1,930.0	78.0	11.1%	6.8%
175	—	**Combustion Engineering**	189.8	3,042.1	56.6	3,042.1	56.6	6.6%	4.6%
176	—	**Oracle Systems**	186.9	186.9	23.3	131.3	15.6	18.9%	16.1%
177	167	**Ametek**	185.0	620.1	41.2	620.1	41.2	16.3%	9.9%
178	—	**Stratus Computer**	184.2	184.2	19.4	184.2	19.4	18.9%	17.6%
179	169	**Sun Electric** [4]	181.6	181.6	2.6	203.9	3.3	4.1%	2.5%
180	173	**ISC Systems**	179.4	179.4	8.1	168.5	6.5	6.5%	5.4%
181	—	**Quantum**	178.3	178.3	8.1	120.8	8.8	8.1%	8.1%
182	186	**ADC Telecommunications**	177.7	177.7	17.4	166.9	15.3	20.1%	19.3%
183	189	**Burndy**	176.0	283.9	11.6	283.9	11.6	7.2%	5.3%
184	200	**Thomas & Betts**	175.0	436.5	48.5	436.5	48.5	16.8%	14.6%
185	—	**Inmac**	174.5	174.5	7.3	165.4	7.7	22.9%	20.0%
186	—	**Oak Industries**	173.1	182.2	5.7	182.2	5.7	7.2%	4.8%
187	160	**Cipher Data Products**	172.9	172.9	5.2	178.2	4.3	3.1%	3.1%
188	—	**VLSI Technology**	172.0	172.0	8.1	172.0	8.1	5.7%	3.9%
189	193	**Coherent**	171.5	171.5	0.7	159.0	-1.1	-1.3%	-1.0%
190	—	**3Com**	171.1	171.1	15.0	110.4	11.1	14.6%	14.5%
191	159	[illegible]	170.0	261.5	-17.9	278.3	5.9	6.5%	3.7%
192	192	**Altos Computer Systems**	168.3	168.3	14.4	153.9	9.7	9.1%	7.4%
193	187	**Intelligent Systems**	163.2	163.2	10.2	163.2	10.2	24.7%	16.4%
194	—	**Cherry Electrical Products**	160.7	187.4	5.6	160.6	2.7	4.4%	2.8%
195	—	**Gencorp**	158.6	1,619.0	18.0	1,619.0	18.0	-9.3%	5.8%
196	171	**Tyco Laboratories**	156.0	1,252.1	51.3	1,062.9	44.1	18.7%	11.7%
197	195	**United Industrial**	155.0	297.5	14.3	297.5	14.3	14.7%	9.8%
198	—	**Brush Wellman**	153.8	307.6	26.2	307.6	26.2	10.8%	8.9%
199	—	**Insilco**	153.2	639.7	33.9	639.7	33.9	11.3%	6.9%
200	190	**Pittway**	152.0	649.1	32.4	649.1	32.4	10.4%	8.5%

[3] went private April 29, 1988

[4] calendar year 1987 includes only 11 months from Feb. to Dec. Changed fiscal year from Oct. to Dec.

NA = not available

NM = not meaningful

Cost of goods as a percentage of revenue	Fiscal year 1987			Five-year growth (Compounded average annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income				
60.4%	5.2%	$96.2	$2.4	7.3%	-13.0%	78.4%	36.5%	22.2%	12/87
52.9%	7.3%	89.5	10.6	14.0%	NM	22.1%	3.5%	59.4%	11/87
76.1%	1.5%	75.1	1.5	4.0%	NM	73.5%	60.3%	15.8%	12/87
43.0%	10.9%	184.9	$16.9	164.1%	NM	43.2%	3.0%	45.9%	12/87
55.9%	12.3%	70.3	3.8	20.6%	4.3%	97.7%	0.0%	13.0%	12/87
87.8%	28.5%	72.6	-11.5	28.8%	NM	-124.9%	12.3%	26.4%	4/87
44.9%	11.3%	96.3	6.0	27.8%	8.8%	45.7%	4.2%	10.0%	3/87
83.1%	0.8%	81.9	2.4	18.9%	14.4%	52.0%	0.0%	NA	3/87
54.3%	6.2%	67.4	3.2	11.3%	1.6%	68.6%	32.2%	46.1%	9/87
74.9%	5.3%	150.0	8.2	NA	NA	39.6%	4.3%	14.8%	7/87
41.6%	10.8%	86.0	0.8	25.9%	-15.7%	66.9%	9.7%	40.5%	9/87
53.8%	17.9%	124.1	0.2	13.9%	NM	119.6%	14.4%	43.9%	10/87
49.7%	2.6%	384.1	30.6	42.1%	36.6%	37.8%	6.0%	23.4%	4/87
28.3%	11.6%	153.0	22.8	66.4%	107.7%	57.4%	0.0%	19.0%	6/87
74.9%	4.3%	89.5	-8.6	1.7%	NM	-23.3%	47.9%	19.8%	12/87
76.7%	0.0%	447.5	11.4	38.5%	27.3%	15.0%	7.5%	NA	12/87
64.4%	2.0%	56.7	2.9	NA	NA	34.8%	55.4%	29.0%	12/87
59.8%	5.0%	81.3	2.4	3.5%	2.6%	86.9%	39.7%	31.1%	12/87
39.2%	13.6%	91.7	1.0	0.6%	-25.1%	66.0%	50.4%	40.4%	12/87
50.6%	12.6%	76.0	0.3	27.0%	NM	134.9%	21.2%	21.9%	9/87
63.5%	4.7%	82.3	-9.3	6.0%	NM	-14.5%	44.6%	39.1%	10/87
73.4%	0.8%	496.3	17.1	18.2%	14.2%	22.1%	37.2%	2.1%	12/87
74.7%	5.7%	123.9	-13.2	20.9%	NM	-31.9%	0.4%	5.5%	11/87
69.3%	3.2%	136.9	5.5	4.2%	14.9%	72.3%	38.7%	12.6%	12/87
82.0%	1.7%	110.3	2.1	5.1%	-10.5%	74.3%	30.1%	33.1%	12/87
61.7%	6.0%	117.1	13.9	NA	NA	80.6%	14.7%	46.8%	5/87
71.0%	3.7%	88.6	5.9	7.9%	8.6%	72.7%	39.1%	NA	12/87
31.7%	10.3%	150.4	15.8	101.8%	NM	49.6%	7.3%	29.2%	12/87
53.2%	2.4%	83.5	1.3	5.5%	NM	55.5%	37.2%	30.0%	10/87
54.4%	8.4%	94.3	3.7	22.1%	-4.2%	68.4%	17.0%	NA	6/87
61.4%	9.5%	173.5	12.7	54.6%	116.3%	42.6%	0.0%	21.0%	3/87
47.8%	9.3%	92.9	8.5	21.8%	26.9%	47.5%	4.3%	12.4%	10/87
60.6%	4.4%	69.9	2.9	4.6%	-5.4%	61.5%	25.4%	44.3%	12/87
45.8%	4.3%	103.9	11.5	9.6%	15.4%	96.8%	13.3%	41.5%	12/87
62.8%	0.0%	258.5	12.1	NA	NA	28.9%	12.9%	59.2%	7/87
77.7%	2.2%	47.4	1.5	-9.6%	NM	47.7%	34.1%	14.4%	12/87
67.9%	11.3%	94.7	2.3	25.0%	12.5%	55.5%	1.8%	18.4%	6/87
42.5%	17.8%	127.9	6.0	51.9%	NM	152.1%	32.5%	22.1%	12/87
58.8%	11.3%	98.3	-0.7	14.6%	9.5%	222.4%	20.8%	46.4%	9/87
46.2%	8.4%	200.0	20.2	NA	NA	43.7%	0.4%	24.0%	5/87
50.1%	3.5%	88.5	1.9	22.7%	-11.6%	31.3%	43.5%	NA	6/87
55.9%	9.0%	196.8	12.4	24.7%	11.1%	199.8%	19.3%	42.0%	6/87
61.6%	4.0%	333.1	20.8	46.0%	26.0%	17.1%	33.6%	26.6%	12/87
66.4%	6.0%	55.7	0.9	12.3%	-8.5%	114.5%	36.8%	49.4%	2/87
77.2%	2.2%	114.8	1.3	NA	NA	200.0%	162.6%	NA	11/87
74.9%	0.5%	100.3	4.2	0.1%	13.7%	68.0%	37.3%	8.8%	5/87
74.7%	0.0%	63.8	3.1	8.5%	4.4%	63.6%	33.0%	NA	12/87
63.5%	2.1%	120.0	10.2	14.4%	8.1%	58.3%	17.9%	26.2%	12/87
64.2%	0.6%	86.5	4.6	0.1%	5.7%	95.1%	38.6%	NA	12/87
59.1%	2.5%	81.1	4.0	9.8%	3.2%	77.2%	18.7%	19.4%	12/87

Source: ELECTRONIC BUSINESS

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THE ELECTRONIC BUSINESS 200

ALPHABETICAL INDEX

COMPANY	RANK
ADC Telecommunications Inc.	182
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AST Research Inc.	122
AT&T Co.	2
AVX Corp.	126
Advanced Micro Devices Inc.	57
Allied-Signal Inc.	18
Altos Computer Systems	192
Amdahl Corp.	41
Ametek Inc.	177
Analog Devices Inc.	97
Andrew Corp.	150
Anthem Electronics Inc.	166
Apollo Computer Inc.	78
Apple Computer Inc.	22
Applied Magnetics Corp.	147
Applied Materials Inc.	162
Arrow Electronics Inc.	77
Ashton-Tate Corp.	132
Atari Corp.	82
Augat Inc.	114
Avantek Inc.	155
Avnet Inc.	42
Ball Corp.	144
Bally Manufacturing Corp.	140
Bell & Howell Co.	168
Bell Industries Inc.	143
Boeing Co., The	33
Bolt Beranek and Newman Inc.	125
BRIntec Corp.	153
Brush Wellman Inc.	198
Burndy Corp.	183
CTS Corp.	138
Cherry Electrical Products Corp.	194
Chrysler Corp.	59
Cincinnati Milacron Inc.	165
Cipher Data Products Inc.	187
Coherent Inc.	189
Combustion Engineering Inc.	175
Compaq Computer Corp.	47
Compugraphic Corp.	100
Computer Associates International Inc.	74
Computervision Corp.	75
Contel Corp.	69
Control Data Corp.	26
Convergent Inc.	98
Cooper Industries Inc.	142
Corning Glass Works	80
Cray Research Inc.	68
Cubic Corp.	117
Cullinet Software Inc.	156
DSC Communications Corp.	115
Data General Corp.	45
Datapoint Corp.	113
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Diasonics Inc.	130
Diebold Inc.	103
Digital Communications Associates Inc.	164
Digital Equipment Corp.	4
Dover Corp.	102
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Dynatech Corp.	104
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EG&G Inc.	91
Eastman Kodak Co.	15
Eaton Corp.	64
Eli Lilly & Co.	118
Emerson Electric Co.	39
Emerson Radio Corp.	63
Emhart Corp.	96
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Figgie International Inc.	134
Fluke Mfg. Co. Inc., John	161
Ford Motor Co.	24
Foxboro Co., The	131
GM Hughes Electronics Corp.	3
GTE Corp.	38
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Gencorp Inc.	195
General DataComm Industries Inc.	170
General Dynamics Corp.	55
General Electric Co.	6
General Instrument Corp.	50
General Signal Corp.	70
Genicom Corp.	119
Gerber Scientific Inc.	141
Gould Inc.	60
Grumman Corp.	51
Harris Corp.	30
Hewlett-Packard Co.	8
Honeywell Inc.	10
IBM Corp.	1
ISC Systems Corp.	180
ITT Corp.	27
Imo Delaval Inc.	167
Inmac Corp.	185
Insilco Corp.	199
Intel Corp.	35
Intelligent Systems Master L.P.	193
Intergraph Corp.	71
Johnson Controls Inc.	62
Kollmorgen Corp.	139
LPL Investment Group	105
LSI Logic Corp.	137
LTV Corp.	93
Litton Industries Inc.	20
Lockheed Corp.	13
Logicon Inc.	158
Loral Corp.	61
Lotus Development Corp.	94
M/A-COM Inc.	88
MAI Basic Four Inc.	109
Mark IV Industries Inc.	116
Marshall Industries	108
Martin Marietta Corp.	23
Maxtor Corp.	145
McDonnell Douglas Corp.	37
Measurex Corp.	152
Medtronic Inc.	79
Mentor Graphics Corp.	154
Micom Systems Inc.	157
Micropolis Corp.	124
Microsoft Corp.	86
MiniScribe Corp.	101
Minnisota Mining & Manufacturing Co.	25
Molex Inc.	90
Monsanto Co.	72
Motorola Inc.	9
NBI Inc.	191
NCR Corp.	11
Nashua Corp.	107
National Semiconductor Corp.	36
Northrop Corp.	49
Oak Industries Inc.	186
Olin Corp.	174
Oracle Systems Corp.	176
Paradyne Corp.	149
Penn Central Corp.	112
Perkin-Elmer Corp., The	46
Pioneer-Standard Electronics Inc.	146
Pitney Bowes Inc.	31
Pittway Corp.	200
Polaroid Corp.	111
Premier Industrial Corp.	120
Prime Computer Inc.	58
Quantum Corp.	181
Raychem Corp.	87
Raytheon Co.	14
Recognition Equipment Inc.	129
Reynolds & Reynolds Co.	148
Rockwell International Corp.	16
SCI Systems Inc.	73
Savin Corp.	133
Scientific-Atlanta Inc.	81
Seagate Technology	53
Singer Co., The	40
SmithKline Beckman Corp.	67
Sprague Technologies Inc.	89
Square D Co.	127
Storage Technology Corp.	66
Stratus Computer Inc.	178
Sun Electric Corp.	179
Sun Microsystems Inc.	65
Sundstrand Corp.	151
TIE/communications Inc.	128
TRW Inc.	19
Tandem Computers Inc.	52
Tandon Corp.	123
Tandy Corp.	17
Tektronix Inc.	44
Teledyne Inc.	48
Teradyne Inc.	99
Texas Instruments Inc.	12
Textron Inc.	92
Thomas & Betts Corp.	184
3Com Corp.	190
Tyco Laboratories Inc.	196
Tyler Corp.	84
Ultimate Corp., The	163
Unisys Corp.	5
United Industrial Corp.	197
United Technologies Corp.	43
United Telecommunications Inc.	83
VLSI Technology Inc.	188
Varian Associates Inc.	56
Veeco Instruments Inc.	159
Wang Laboratories Inc.	21
Watkins-Johnson Co.	136
Western Digital Corp.	76
Westinghouse Electric Corp.	28
Westmark International Inc.	121
Wyle Laboratories Inc.	135
Wyse Technology	95
Xerox Corp.	7
Xidex Corp.	85
Zenith Electronics Corp.	29

THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1987 figures Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
COMMUNICATIONS								
Dynascan	$496.3	3.4%	9.1%	73.4%	0.8%	0.9%	2.1%	172
3Com	200.0	10.1%	14.5%	46.2%	8.4%	5.7%	24.0%	190
TIE/communications	166.8	-4.4%	-5.1%	66.7%	8.6%	1.7%	30.3%	128
Digital Communications	153.0	14.9%	17.2%	28.3%	[illegible]	10.5%	19.0%	164
Scientific-Atlanta	147.9	4.9%	11.6%	69.0%	4.1%	1.4%	15.0%	81
DSC Communications	122.8	4.7%	5.1%	49.6%	13.1%	7.4%	14.4%	115
Dynatech	98.3	7.6%	13.9%	40.8%	9.0%	4.1%	25.4%	104
Andrew	97.0	1.7%	2.2%	63.1%	4.7%	5.2%	40.7%	150
Micom Systems	96.3	6.2%	6.8%	44.9%	11.3%	4.6%	10.0%	157
ADC Telecommunications	92.9	9.1%	19.3%	47.8%	9.3%	6.7%	12.4%	182
Bolt Beranek and Newman	87.6	-3.4%	-8.7%	52.8%	6.1%	9.5%	0.0%	125
General DataComm Industries	76.0	0.4%	0.7%	50.6%	12.6%	7.6%	21.9%	170
Paradyne	74.7	-1.1%	-1.1%	53.0%	8.2%	5.2%	17.9%	149
Avantek	70.3	5.4%	7.5%	55.9%	12.3%	11.4%	13.0%	155
Motorola	68.6	4.6%	8.3%	53.2%	7.8%	9.8%	43.8%	9
M/A-COM	64.6	-6.7%	-7.5%	69.0%	5.6%	6.1%	21.5%	88
General Instrument	48.3	2.3%	2.8%	76.5%	3.1%	8.0%	16.2%	50
Weighted average	**$74.7**	**3.8%**	**6.1%**	**55.8%**	**7.5%**	**8.3%**	**33.3%**	
GOVERNMENT								
GM Hughes Electronics	$104.8	5.0%	6.7%	72.3%	4.0%	4.5%	11.6%	3
Gould	92.2	2.7%	3.0%	49.4%	10.1%	5.2%	38.0%	60
Harris	85.6	4.1%	7.4%	58.8%	5.7%	4.0%	14.7%	30
Honeywell	84.7	3.8%	7.0%	66.8%	4.3%	4.6%	20.6%	10
Watkins-Johnson	84.4	6.5%	12.0%	58.7%	6.4%	4.7%	19.0%	136
SCI Systems	83.0	2.9%	5.0%	93.0%	0.0%	5.4%	24.8%	73
Varian Associates	82.6	2.2%	4.1%	65.0%	8.2%	4.7%	23.6%	56
Logicon	81.9	3.0%	10.5%	83.1%	0.8%	1.9%	0.0%	158
Litton Industries	81.5	3.1%	10.8%	76.1%	4.7%	5.5%	22.7%	20
Cubic	80.4	2.2%	4.1%	73.4%	1.4%	4.7%	0.0%	117
E-Systems	79.1	4.9%	11.8%	81.4%	2.7%	4.2%	6.6%	54
Texas Instruments	71.7	4.6%	9.2%	71.5%	7.7%	8.3%	31.5%	12
Motorola	68.6	4.6%	8.3%	53.2%	7.8%	9.8%	43.8%	9
Singer	68.0	1.2%	1.5%	92.2%	2.0%	4.1%	0.0%	40
Loral	47.6	8.3%	13.6%	73.9%	4.6%	5.0%	6.2%	61
Weighted average	**$75.8**	**3.9%**	**7.4%**	**67.7%**	**5.7%**	**6.4%**	**25.4%**	
DISTRIBUTORS								
Anthem Electronics	$447.5	2.5%	6.7%	76.7%	0.0%	0.5%	0.0%	166
Arrow Electronics	308.0	-2.8%	-10.0%	79.4%	0.0%	0.4%	0.0%	77
Marshall Industries	260.6	1.8%	5.1%	75.1%	0.0%	3.2%	0.0%	108
Pioneer-Standard Electronics	253.6	0.9%	2.2%	75.3%	0.0%	1.1%	0.0%	146
Wyle Laboratories	169.5	1.6%	4.3%	76.7%	0.0%	1.0%	0.0%	135
Avnet	162.8	1.5%	2.6%	73.5%	0.0%	3.1%	0.0%	42
Weighted average	**$199.9**	**0.8%**	**1.7%**	**75.4%**	**0.0%**	**2.1%**	**0.0%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1987 figures

Company	**Revenue per employee** ($ thousands)	**Profit as a percentage of revenue**	**Return on investment**	**Cost of goods sold as a percentage of revenue**	**R&D as a percentage of revenue**	**Capital expenditures as a percentage of revenue**	**Foreign revenue as a percentage of revenue**	**200 rank**
CAPITAL EQUIPMENT								
Gerber Scientific	$124.4	9.4%	11.7%	46.8%	7.4%	4.7%	47.0%	141
Applied Materials	124.1	0.2%	0.2%	53.8%	17.9%	6.6%	43.9%	162
Hewlett-Packard	98.7	8.0%	10.6%	42.6%	11.1%	6.3%	49.0%	8
Perkin-Elmer	94.5	-1.4%	-2.0%	52.6%	10.5%	5.0%	46.2%	46
GenRad	91.7	1.1%	1.4%	39.2%	13.6%	6.0%	40.4%	169
John Fluke	86.0	1.0%	1.7%	41.6%	10.8%	4.0%	40.5%	161
Sun Electric	83.5	1.6%	2.5%	53.2%	2.4%	2.3%	30.0%	179
Varian Associates	82.6	2.2%	4.1%	65.0%	8.2%	4.7%	23.6%	56
Esterline	82.3	-11.3%	-21.6%	63.5%	4.7%	1.0%	39.1%	171
Tektronix	81.6	3.7%	5.7%	39.8%	14.3%	4.8%	42.2%	44
Teradyne	80.4	-5.7%	-6.5%	50.2%	16.3%	10.8%	36.4%	99
Weighted average	**$93.9**	**5.0%**	**7.0%**	**45.8%**	**11.1%**	**5.8%**	**45.0%**	
OFFICE EQUIPMENT								
Savin	$176.4	0.0%	0.1%	57.8%	1.3%	0.3%	10.8%	133
IBM	139.3	9.7%	12.0%	38.9%	10.0%	7.9%	54.0%	1
Datapoint	113.5	-18.7%	-20.1%	57.8%	6.2%	8.2%	79.2%	113
Xerox	104.2	5.6%	7.5%	45.1%	7.0%	9.1%	44.9%	7
Wang Laboratories	93.6	2.5%	3.1%	27.1%	7.5%	4.5%	40.1%	21
NCR	91.0	7.4%	17.7%	48.8%	6.3%	6.9%	54.6%	11
Diebold	90.0	8.1%	10.3%	64.6%	3.3%	1.9%	7.0%	103
Harris	85.6	4.1%	7.4%	58.8%	5.7%	4.0%	14.7%	30
Pitney Bowes	76.4	8.9%	13.5%	31.7%	2.9%	11.2%	19.5%	31
Weighted average	**$121.8**	**8.4%**	**11.1%**	**40.6%**	**8.9%**	**7.8%**	**50.0%**	
COMPUTER-BASED SYSTEMS								
Gerber Scientific	$124.4	9.4%	11.7%	46.8%	7.4%	4.7%	47.0%	141
Intergraph	101.8	10.9%	12.2%	45.1%	10.5%	6.8%	36.9%	71
Hewlett-Packard	98.7	8.0%	10.6%	42.6%	11.1%	6.3%	49.0%	8
Coherent	98.3	-0.7%	-1.0%	58.8%	11.3%	5.3%	46.4%	189
ISC Systems	94.3	3.9%	5.4%	54.4%	8.4%	5.2%	0.0%	180
Recognition Equipment	90.7	4.2%	5.6%	53.5%	4.4%	8.2%	49.1%	129
Measurex	89.5	11.8%	15.2%	52.9%	7.3%	3.0%	59.4%	152
Honeywell	84.7	3.8%	7.0%	66.8%	4.3%	4.6%	20.6%	10
Sun Electric	83.5	1.6%	2.5%	53.2%	2.4%	2.3%	30.0%	179
Weighted average	**$92.4**	**6.2%**	**9.2%**	**53.1%**	**8.0%**	**5.5%**	**36.5%**	
MEDICAL								
Diasonics	$177.2	5.7%	12.1%	58.4%	6.9%	3.0%	3.1%	130
Medtronic	101.4	14.7%	17.4%	28.4%	8.4%	5.7%	41.5%	79
Westmark International	96.6	-2.5%	-3.1%	55.6%	9.6%	3.6%	28.0%	121
Weighted average	**$111.9**	**7.7%**	**10.4%**	**43.5%**	**8.3%**	**4.4%**	**28.1%**	

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THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1987 figures Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
SEMICONDUCTORS								
Western Digital	$138.5	9.3%	20.3%	59.3%	8.1%	8.8%	36.9%	76
VLSI Technology	127.9	4.7%	3.9%	42.5%	17.8%	29.1%	22.1%	188
LSI Logic	113.0	4.1%	2.2%	48.7%	11.0%	66.6%	14.6%	137
Intel	99.3	9.2%	8.5%	45.7%	13.6%	15.8%	38.8%	35
Gould	92.2	2.7%	3.0%	49.4%	10.1%	5.2%	38.0%	60
Harris	85.6	4.1%	7.4%	58.8%	5.7%	4.0%	14.7%	30
Texas Instruments	71.7	4.6%	9.[illegible]%	71.5%	7.7%	8.3%	31.5%	12
Analog Devices	71.2	5.0%	5.6%	37.3%	15.1%	11.6%	46.4%	97
Motorola	68.6	4.6%	8.3%	53.2%	7.8%	9.8%	43.8%	9
National Semiconductor	64.0	-1.5%	-2.9%	62.1%	11.7%	5.1%	42.1%	36
Advanced Micro Devices	55.3	-4.8%	-6.0%	41.1%	24.9%	13.8%	27.2%	57
Weighted average	**$74.0**	**4.0%**	**6.3%**	**57.6%**	**9.6%**	**9.8%**	**35.5%**	
COMPONENTS (other than semiconductors)								
AMP	$105.4	10.8%	16.3%	56.8%	8.8%	7.4%	52.3%	34
Augat	82.4	3.7%	4.8%	68.1%	5.1%	9.4%	18.0%	114
Molex	77.9	11.2%	13.3%	46.2%	5.5%	12.8%	68.4%	90
BRIntec	75.1	2.0%	4.0%	76.1%	1.5%	3.2%	15.8%	153
Cherry Electrical Products	55.7	1.7%	2.8%	66.4%	6.0%	9.6%	49.4%	194
Sprague Technologies	50.8	0.8%	1.0%	74.1%	4.8%	5.6%	38.2%	89
Oak Industries	47.4	3.1%	4.8%	77.7%	2.2%	3.4%	14.4%	186
CTS	39.3	4.0%	6.3%	75.5%	2.0%	5.1%	19.7%	138
AVX	36.3	5.8%	4.8%	66.0%	3.1%	11.7%	43.0%	126
Weighted average	**$72.1**	**7.5%**	**10.5%**	**62.3%**	**6.4%**	**7.6%**	**43.7%**	
PERIPHERALS								
Intelligent Systems	$333.1	6.2%	16.4%	61.6%	4.0%	1.7%	26.6%	193
Quantum	173.5	7.3%	8.1%	61.4%	9.5%	4.9%	21.0%	181
AST Research	151.7	6.3%	13.1%	56.1%	5.4%	3.0%	19.6%	122
Wyse Technology	128.7	7.0%	18.2%	66.4%	5.3%	3.1%	20.2%	95
Decision Industries	123.9	-10.7%	-27.8%	74.7%	5.7%	2.6%	5.5%	173
Micropolis	120.9	9.4%	12.7%	72.7%	7.5%	7.7%	69.7%	124
Control Data	97.6	0.7%	1.7%	63.3%	11.6%	5.3%	20.0%	26
Cipher Data Products	94.7	2.4%	3.1%	67.9%	11.3%	3.3%	18.4%	187
Maxtor	90.9	12.8%	10.7%	61.9%	6.7%	9.9%	16.0%	145
Dataproducts	86.9	2.6%	3.3%	64.5%	6.6%	3.2%	26.8%	110
Storage Technology	84.6	2.5%	3.1%	59.5%	8.0%	23.9%	0.0%	66
Genicom	84.2	4.2%	7.5%	64.8%	4.9%	3.1%	32.0%	119
Xidex	83.0	-7.8%	-8.4%	76.7%	2.0%	0.4%	29.9%	85
Tandon	82.4	5.9%	15.2%	70.4%	3.6%	4.2%	75.0%	123
MiniScribe	72.9	7.8%	14.0%	71.3%	5.5%	13.9%	36.1%	101
Seagate Technology	59.9	14.6%	21.3%	68.6%	3.5%	8.2%	43.6%	53
Applied Magnetics	30.5	6.7%	9.2%	64.9%	9.2%	12.1%	46.5%	147
Weighted average	**$86.1**	**3.5%**	**5.8%**	**65.6%**	**7.9%**	**7.1%**	**26.7%**	

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THE ELECTRONIC BUSINESS 200

INDUSTRY SEGMENTS

Fiscal 1987 figures

Company	**Revenue per employee** ($ thousands)	**Profit as a percentage of revenue**	**Return on investment**	**Cost of goods sold as a percentage of revenue**	**R&D as a percentage of revenue**	**Capital expenditures as a percentage of revenue**	**Foreign revenue as a percentage of revenue**	**200 rank**
MAINFRAMES								
Amdahl	$198.0	9.4%	15.4%	47.8%	11.9%	10.5%	44.3%	41
Cray Research	159.5	21.4%	20.2%	11.4%	15.8%	5.8%	37.0%	68
IBM	139.3	9.7%	12.0%	38.9%	10.0%	7.9%	54.0%	1
Unisys	105.0	6.0%	8.7%	32.5%	6.1%	7.4%	43.6%	5
Control Data	97.6	0.7%	1.7%	63.3%	11.6%	5.3%	20.0%	26
NCR	91.0	7.4%	17.7%	48.8%	6.3%	6.9%	54.6%	11
Weighted average	**$127.3**	**8.7%**	**11.8%**	**39.8%**	**9.4%**	**7.7%**	**50.8%**	
MINICOMPUTERS								
Stratus Computer	$150.4	10.5%	17.6%	31.7%	10.3%	7.5%	29.2%	178
Tandem Computers	147.8	10.2%	14.4%	29.6%	10.5%	13.7%	44.4%	52
IBM	139.3	9.7%	12.0%	38.9%	10.0%	7.9%	54.0%	1
Apollo Computer	138.4	3.9%	6.3%	44.5%	11.0%	9.7%	51.8%	78
Sun Microsystems	128.5	6.8%	9.0%	46.1%	12.9%	14.2%	32.0%	65
Prime Computer	109.0	6.7%	6.1%	38.2%	11.4%	10.5%	48.0%	58
MAI Basic Four	98.7	7.1%	17.6%	44.6%	4.0%	4.1%	64.1%	109
Hewlett-Packard	98.7	8.0%	10.6%	42.6%	11.1%	6.3%	49.0%	8
Gould	92.2	2.7%	3.0%	49.4%	10.1%	5.2%	38.0%	60
Digital Equipment	85.0	12.1%	17.3%	22.3%	10.8%	8.0%	47.0%	4
Data General	81.2	-6.5%	-11.7%	47.8%	12.5%	11.2%	45.0%	45
Weighted average	**$121.8**	**9.4%**	**11.9%**	**37.5%**	**10.3%**	**7.9%**	**51.9%**	
MICROCOMPUTERS								
Apple Computer	$475.2	8.2%	26.0%	46.1%	7.2%	3.2%	27.1%	22
Compaq Computer	306.0	11.1%	24.8%	56.8%	3.8%	9.3%	26.0%	47
Altos Computer Systems	196.8	6.3%	7.4%	55.9%	9.0%	18.8%	42.0%	192
AST Research	151.7	6.3%	13.1%	56.1%	5.4%	3.0%	19.6%	122
IBM	139.3	9.7%	12.0%	38.9%	10.0%	7.9%	54.0%	1
Atari	120.6	9.0%	14.2%	60.8%	3.7%	0.8%	45.9%	82
Tandy	88.5	7.0%	15.3%	47.4%	0.0%	2.7%	1.6%	17
Tandon	82.4	5.9%	15.2%	70.4%	3.6%	4.2%	75.0%	123
Zenith Electronics	67.5	-0.8%	-2.1%	83.7%	4.4%	2.3%	17.2%	29
Weighted average	**$134.8**	**9.1%**	**12.3%**	**42.0%**	**9.0%**	**7.2%**	**48.2%**	
SOFTWARE								
Ultimate	$384.1	8.0%	14.5%	49.7%	2.6%	4.6%	23.4%	163
Ashton-Tate	213.9	16.1%	23.0%	11.6%	10.5%	2.4%	30.3%	132
Microsoft	190.5	20.8%	29.2%	19.2%	11.0%	16.8%	42.3%	86
Lotus Development	188.4	18.2%	30.0%	13.4%	14.8%	6.7%	52.3%	94
Mentor Graphics	184.9	9.2%	10.5%	43.0%	10.9%	6.6%	45.9%	154
Oracle Systems	117.1	11.9%	16.1%	61.7%	6.0%	12.9%	46.8%	176
Computer Associates International	114.6	11.8%	11.1%	-8.8%	13.0%	3.4%	48.7%	74
Cullinet Software	72.6	-15.8%	-20.3%	87.8%	28.5%	6.3%	26.4%	156
Weighted average	**$154.8**	**12.2%**	**16.1%**	**26.7%**	**12.4%**	**7.5%**	**41.3%**	

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THE ELECTRONIC BUSINESS 200

BEST AND WORST PERFORMERS

NET INCOME/REVENUE

(percentage)

		200 rank
TOP 10		
Cray Research	21.4%	68
Microsoft	20.8%	86
Lotus Development	18.2%	94
Ashton-Tate	16.1%	132
Digital Communications	14.9%	164
Medtronic	14.7%	79
Seagate Technology	14.6%	53
SmithKline Beckman	13.2%	67
Maxtor	12.8%	145
Digital Equipment	12.1%	4
MEDIAN	4.7%	
BOTTOM 5		
Decision Industries	-10.7%	173
Esterline	-11.3%	171
Cullinet Software	-15.8%	156
Datapoint	-18.7%	113
Foxboro	-19.2%	131

R&D/REVENUE

(percentage)

		200 rank
TOP 10		
Cullinet Software	28.5%	156
Advanced Micro Devices	24.9%	57
Applied Materials	17.9%	162
VLSI Technology	17.8%	188
Teradyne	16.3%	99
Cray Research	15.8%	68
Analog Devices	15.1%	97
Lotus Development	14.8%	94
Tektronix	14.3%	44
Intel	13.6%	35
MEDIAN	5.4%	

For those 183 companies that reported research & development expenditures

RETURN ON EQUITY

(percentage)

		200 rank
TOP 10		
Seagate Technology	39.5%	53
SmithKline Beckman	36.0%	67
Lotus Development	35.7%	94
Compaq Computer	34.1%	47
Microsoft	30.1%	86
MAI Basic Four	29.3%	109
MiniScribe	27.8%	101
Emerson Radio	27.7%	63
General Dynamics	27.3%	55
Atari	26.3%	82
MEDIAN	11.2%	
BOTTOM 5		
Decision Industries	-28.0%	173
Datapoint	-32.2%	113
Cincinnati Milacron	-37.2%	165
Esterline	-39.1%	171
Foxboro	-51.5%	131

RETURN ON INVESTMENT

(percentage)

		200 rank
TOP 10		
Lotus Development	30.0%	94
Microsoft	29.2%	86
Apple Computer	26.0%	22
Compaq Computer	24.8%	47
Ashton-Tate	23.0%	132
General Dynamics	21.6%	55
Seagate Technology	21.3%	53
Ford Motor	21.0%	24
SmithKline Beckman	20.4%	67
Western Digital	20.3%	76
MEDIAN	7.5%	
BOTTOM 5		
Cullinet Software	-20.3%	156
Esterline	-21.6%	171
LTV	-25.0%	93
Decision Industries	-27.8%	173
Foxboro	-40.1%	131

THE ELECTRONIC BUSINESS 200

BEST AND WORST PERFORMERS

REVENUE PER EMPLOYEE

($ thousands)

		200 rank
TOP 10		
Emerson Radio	$1,012.6	63
Dynascan	496.3	172
Apple Computer	475.2	22
Anthem Electronics	447.5	166
Ultimate	384.1	163
Intelligent Systems	333.1	193
Arrow Electronics	308.0	77
Compaq Computer	306.0	47
Marshall Industries	260.6	108
Inmac	258.5	185
MEDIAN	$97.0	
BOTTOM 5		
Loral	$47.6	61
Oak Industries	47.4	186
CTS	39.3	138
AVX	36.3	126
Applied Magnetics	30.5	147

NET INCOME PER EMPLOYEE

($ thousands)

		200 rank
TOP 10		
Microsoft	$39.6	86
Apple Computer	38.8	22
Ashton-Tate	34.5	132
Lotus Development	34.3	94
Cray Research	34.1	68
Compaq Computer	34.1	47
Emerson Radio	33.3	63
Ultimate	30.6	163
Digital Communications	22.8	164
Intelligent Systems	20.8	193
MEDIAN	$4.3	
BOTTOM 5		
Esterline	-$9.3	171
Cullinet Software	-11.5	156
Decision Industries	-13.2	173
Foxboro	-13.8	131
Datapoint	-21.3	113

FIVE-YEAR REVENUE GROWTH

(compounded average annual growth rate)

		200 rank
TOP 10		
Sun Microsystems	474.4%	65
Lotus Development	356.3%	94
AST Research	249.5%	122
Mentor Graphics	164.1%	154
MiniScribe	135.5%	101
LSI Logic	120.8%	137
Wyse Technology	102.7%	95
Stratus Computer	101.8%	178
Apollo Computer	98.2%	78
Seagate Technology	88.3%	53
MEDIAN	11.6%	
BOTTOM 5		
Storage Technology	-7.0%	66
Datapoint	-9.3%	113
Oak Industries	-9.6%	186
ITT	-11.7%	27
Penn Central	-14.8%	112

FIVE-YEAR NET INCOME GROWTH

(compounded average annual growth rate)

		200 rank
TOP 10		
Micropolis	206.9%	124
Emerson Radio	145.2%	63
Apollo Computer	135.4%	78
Quantum	116.3%	181
Digital Communications	107.7%	164
Amdahl	96.1%	41
Microsoft	83.0%	86
Seagate Technology	82.5%	53
Northrop	79.9%	49
Ashton-Tate	74.0%	132
MEDIAN	8.9%	
BOTTOM 5		
Penn Central	-23.3%	112
GenRad	-25.1%	169
General Instrument	-28.1%	50
Control Data	-30.6%	26
Kollmorgen	-50.6%	139

THE ELECTRONIC BUSINESS 200

BEST AND WORST PERFORMERS

FOREIGN REVENUE/TOTAL REVENUE

(percentage of total revenue)

TOP 10		200 rank
Datapoint	79.2%	113
Tandon	75.0%	123
Micropolis	69.7%	124
Molex	68.4%	90
MAI Basic Four	64.1%	109
Raychem	61.6%	87
Measurex	59.4%	152
Inmac	59.2%	185
NCR	54.6%	11
IBM	54.0%	1
MEDIAN	28.0%	
BOTTOM 5		
Loral	6.2%	61
Decision Industries	5.5%	173
Diasonics	3.1%	130
Dynascan	2.1%	172
Tandy	1.6%	17

CAPITAL EXPENDITURES

(percentage of net cash flow after dividends)

TOP 10		200 rank
Data General	576.1%	45
Perkin-Elmer	492.2%	46
Bolt Beranek and Newman	489.1%	125
Teradyne	374.1%	99
Westmark International	366.7%	121
LSI Logic	339.5%	137
Zenith Electronics	247.3%	29
Coherent	222.4%	189
United Telecommunications	218.9%	83
Gencorp	200.0%	195
MEDIAN	65.2%	
BOTTOM 5		
Cullinet Software	-124.9%	156
Xidex	-150.0%	85
TIE/communications	-187.6%	128
M/A-COM	-295.1%	88
Convergent	-600.3%	98

THE 200: ARRIVALS AND DEPARTURES

ARRIVALS	1987 rank
Computer Associates	74
Raychem	87
Sprague Technologies	89
LPL Investment Group	105
MAI Basic Four	109
Westmark International	121
Cullinet Software	156
Everex Systems	160
Imo Delaval	167
Combustion Engineering	175
Oracle Systems	176
Stratus Computer	178
Quantum	181
Inmac	185
Oak Industries	186
VLSI Technology	188
3Com	190
Cherry Electrical	194
Gencorp	195
Brush Wellman	198
Insilco	199

DEPARTURES	1986 rank
ADT[1]	163
Allen Group	165
Analogic	170
Aydin	196
Becton, Dickinson	181
Data Card[2]	175
Ducommun[3]	87
Electrospace Systems[4]	161
Fairchild Industries	197
International Rectifier	177
Kidde[5]	162
Mark Controls	185
Monolithic Memories[6]	140
North American Philips[7]	18
Spectra-Physics[8]	142
Sun Chemical[9]	191
Telex[10]	62
Tracor[11]	76
UCCEL[12]	188
Union Carbide	122
Unitrode	182

[1] acquired by Hawley Group Ltd.Oct. 5, 1987

[2] acquired by Seedham Inc. Sept. 4, 1987

[3] sold its electronics distribution businesses to Arrow Electronics Inc. Jan. 12, 1988

[4] acquired by Chrysler Corp. Aug. 21, 1987

[5] acquired by Hanson Trust Plc Jan. 5, 1988

[6] acquired by Advanced Micro Devices Aug. 12, 1987

[7] owned by N.V. Philips

[8] acquired by Ciba-Geigy Ltd.

[9] changed name to Sequa Corp.

[10] acquired by Memorex International N.V. Jan. 28, 1988

[11] acquired by Westmark Systems Inc. (privately held) Dec. 22, 1987

[12] acquired by Computer Associates International Inc. Aug. 20, 1987

Stop harping about Japan's electronics prowess

In terms of productivity, sales and net income growth, the top U.S. electronics firms outperformed their Japanese rivals last year

BY PAULA DOE

After two hard years, Japan's major electronics producers are starting to see results from their efforts to cope with the high-valued yen. Sales of the top 20 electronics companies in Japan revived to a healthy 9.9% growth rate for the fiscal year ended March 1988. And net income for the same group of companies surged 35.4% during the same time period.

Nonetheless, U.S. companies did better across the board (see accompanying table). Although sales of the leading U.S. electronics producers only slightly outpaced those of their Japanese counterparts, net income grew significantly faster. The top 20 U.S. electronics companies' net income surged 48.1% last year. The U.S. companies' aggregate net income was 7.5% of sales, roughly three times the Japanese percentage.

ELECTRONIC BUSINESS tracks the consolidated financial results for the 20 largest electronics companies in Japan. The Japanese figures (see accompanying table) are then compared against those from the top 20 U.S. electronics companies from our ELECTRONIC BUSINESS 200 listing, published in our July 15th issue.

In spite of Japan's intense efforts to improve productivity during the past couple of years, the U.S. sector made greater gains. While Japanese sales per employee were up 10.1%, the top 20 U.S. companies saw 12.4% improvement. And in terms of net income per employee, the Japanese growth of 38.1% was outpaced by the U.S. increase of 48.4%. In fact, U.S. productivity growth has been significantly higher for each of the past three years since ELECTRONIC BUSINESS began compiling these figures.

Revenue and earnings per employee are crude ways to compare productivity, since they reflect market forces as well as output. However, better measures are hard to come by and, whatever the actual levels, the rate of change in revenue and earnings per employee still suggest a general trend in productivity growth.

While the United States is increasing its productivity faster than Japan, the Japanese appear to still be more productive. The average Japanese revenue per employee of $211,400 was twice that of the United States. Still, the revenue-per-employee figures for Japan are artificially inflated by the web of affiliated firms that surrounds the major Japanese electronics corporations. Although the parent corporation's relationship with its affiliated supplier or distributor may be close, the parent typically does not own a high percentage of the affiliate, so the affiliate's workers are not counted in the parent's consolidated total of employees.

Furthermore, the Japan revenue-per-employee figures also looked huge last year because of the appreciation of the yen against the dollar.

Rod Thomas

In actuality, the figures for the top Japanese companies remain at only about 55% of their peak levels of 1984. U.S. revenue per employee, on the other hand, is up 16% from 1984.

Revenue figures aside, the U.S. top 20 far outpace their Japanese rivals in terms of income productivity. The average net income per employee figure for Japan was only $5,000, much less than the U.S. average of $7,900.

Kudos for the Japanese

Still, the Japanese deserve kudos for riding out the wild fluctuations in their currency. Japanese sales growth last year almost caught back up with U.S. levels. The 9.9% growth in yen-based electronics revenue at the big Japanese producers approached the 12.5% increase at the top 20 U.S. producers. In sharp contrast, Japanese sales two years ago were flat as the high yen devastated export sales. U.S. companies maintained 4% to 5% growth that year. The 9.9% growth in electronics sales outpaced the 7.1% increase in total sales at the Japanese companies, as producers began to successfully move to higher value-added products — fewer toasters and fans, more computers and VCR camcorders.

Mitsubishi Electric Corp. led the Japanese recovery last year with a dramatic 55% increase in electronics revenue. Oki Electric Industry Company Ltd. also made a significant comeback with a 19% sales growth, after a rough year in 1986. Fujitsu Ltd. saw an impressive 14% increase in revenue, while NEC Corp. and Omron Tateisi Electronics Co. both saw 11% growth in overall sales. On the other hand, Hitachi Ltd. experienced a 6% decline in electronics revenue, but the company's total sales increased 3%. Sanyo Electric Company Ltd. saw its sales dip 14%.

With growth reviving and the yen strengthening against the dollar, the leading Japanese electronics producers look bigger and bigger. The top seven companies in Japan now have electronics sales exceeding $10 billion each. To make last year's top 20 list, a company had to have electronics sales of at least $2 billion. In fact, total sales of the Japanese top 20 are now 15% more than those of the 20 largest U.S. producers, and come to some 58% of those of the total ELECTRONIC BUSINESS 200.

In addition to revenue, earnings for the Japanese also started to recover after plummeting in each of the past two years. Thanks to intensive cost cutting efforts, companies reported big percentage increases in earnings last year, although margins still remain extremely thin. Net income was up 35.4%, but remained a meager 2.6% of sales, reflecting no change from the 2% to 3% of the last several years.

A 579% growth

Of the Japanese top 20, Omron had the most impressive earnings gain. The company's net income last year swelled 579% to $166 million. Oki experienced a 144% surge in net income to $40 million. Mitsubishi saw a 110% gain. Sanyo, however, reported a net income loss of $140 million. The Osaka-based corporation, heavily dependent on exports, was

Japanese versus U.S. electronics companies in 1987*

	Japanese top 20	U.S. top 20
Electronics revenue ($ billions)	$173.1	$151.5
Change from 1986	+9.9%	+12.5%
Total revenue ($ billions)	$275.3	$154.2
Change from 1986	+7.1%	+12.2%
Net income ($ billions)	$6.8	$11.5
Change from 1986	+35.4%	+48.1%
Net income/sales	2.6%	7.5%
Revenue per employee	$211,400	$105,734
Change from 1986	+10.1%	+12.4%
Net income per employee	$5,000	$7,898
Change from 1986	+38.1%	+48.4%

Conversion rate: ¥ 125 = $1

* For Japanese companies, fiscal year ended March 1988

Source: ELECTRONIC BUSINESS

the only major Japanese electronics company to lose money last year.

Only a very few of the most successful companies managed to earn more than 10 cents on the dollar from operations and more than 4 cents in net income. Nippon Telegraph and Telephone Corp., with its lucrative domination of the telecommunications market in Japan, had operating income of 15% of revenue and net income of 4%. Kyocera Corp., with its domination of the worldwide ceramic package market, had operating income of 14% of sales, and net of 7.5%. Kyocera recently forecast a 23.4% increase in pretax recurring profits for the current fiscal year. TDK Electronics Company Ltd. also maintained its relatively healthy bottom line with operating income of 12% and net of 4.5%.

Everybody else had operating income amounting to 5% of sales or less, and net income of 3% or less. Reliable consolidated figures for other measures of return, such as return on equity or return on investment, were not yet available for most of the Japanese companies. ☐

Japan's top electronics companies in 1987

		Electronics revenue ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Net income as a percentage of revenue	Revenue per employee	Net income per employee	Fiscal year ended
1	**Matsushita**[1]	$28,500	$38,552	$1,303	3.4%	$285,600	$9,600	3/88
	Change from 1986	11%	5%	-0.5%	—	—	—	
2	**NEC**	21,700	21,718	203	0.9%	212,000	2,000	3/88
	Change from 1986	11%	11%	69%	—	—	—	
3	**Toshiba**	17,100	28,579	486	1.7%	234,000	4,000	3/88
	Change from 1986	13%	8%	78%	—	—	—	
4	**Hitachi**	16,600	39,081	1,094	2.7%	248,900	6,800	3/88
	Change from 1986	-6%	3%	39%	—	—	—	
5	**Fujitsu**[2]	16,400	16,374	337	2.1%	172,700	3,600	3/88
	Change from 1986	14%	14%	95%	—	—	—	
6	**Sony**[1]	11,700	11,655	294	2.5%	192,600	4,900	3/88
	Change from 1986	10%	10%	-12%	—	—	—	
7	**Mitsubishi**[1]	11,400	18,946	178	0.9%	256,000	2,400	3/88
	Change from 1986	55%	12%	110%	—	—	—	
8	**Sharp**[2,3]	8,100	9,880	160	1.6%	184,700	3,000	3/88
	Change from 1986	12%	8%	-4%	—	—	—	
9	**Canon**	7,300	7,814	106	1.3%	208,200	2,800	12/87
	Change from 1986	8%	10%	24%	—	—	—	
10	**Sanyo**	5,700	9,491	-140	-1.5%	233,800	-3,500	11/87
	Change from 1986	-14%	0%	-933%	—	—	—	
11	**Ricoh**[3]	4,400	5,200	110	2.2%	185,700	4,000	3/88
	Change from 1986	11%	10%	28%	—	—	—	
12	**Oki**[3]	3,900	3,880	40	1.1%	192,600	2,100	3/88
	Change from 1986	19%	19%	144%	—	—	—	
13	**TDK**	3,200	3,186	145	4.5%	199,100	9,000	11/87
	Change from 1986	5%	3%	17%	—	—	—	
14	**Pioneer**	2,900	2,924	91	3.1%	225,000	7,000	3/88
	Change from 1986	3%	5%	111%	—	—	—	
15	**NTT**[2]	2,900	45,296	1,946	4.3%	155,600	6,700	3/88
	Change from 1986	8%	6%	64%	—	—	—	
16	**Alps**[2]	2,800	2,964	66	2.2%	197,600	4,400	3/88
	Change from 1986	0%	0%	107%	—	—	—	
17	**Omron**	2,400	2,414	166	2.6%	166,500	11,400	3/88
	Change from 1986	8%	11%	579%	—	—	—	
18	**Kyocera**	2,100	2,403	181	7.5%	150,200	11,300	3/88
	Change from 1986	12%	9%	30%	—	—	—	
19	**Citizen**[2,3]	2,000	2,200	40	1.8%	262,800	4,700	3/88
	Change from 1986	7%	4%	46%	—	—	—	
20	**Casio**[3]	2,000	2,040	40	1.8%	264,200	4,700	3/88
	Change from 1986	7%	12%	57%	—	—	—	

Conversion rate: ¥125 = $1

[1] Comparisons are with the company's last full fiscal year, ending 11/86 for Matsushita and 10/86 for Sony. Both companies recently changed their fiscal year and released only partial results for the period ending 3/87

[2] Consolidation by Japanese accounting conventions, which differ from U.S. Securities and Exchange Commission rules

[3] Preliminary figures before release of final consolidated results

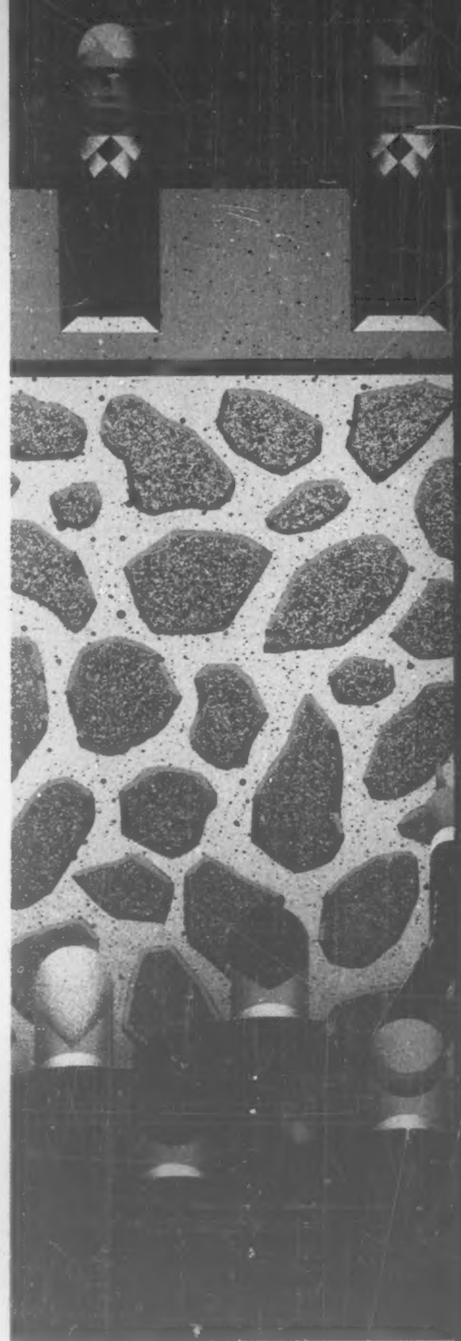
Source: ELECTRONIC BUSINESS

EC firms have embarked on international crusades to expand their influence. These campaigns could leave unprepared U.S. firms outside the kingdom gates.

Inside the fortress

Europe after 1992

BY SHERRY BUCHANAN



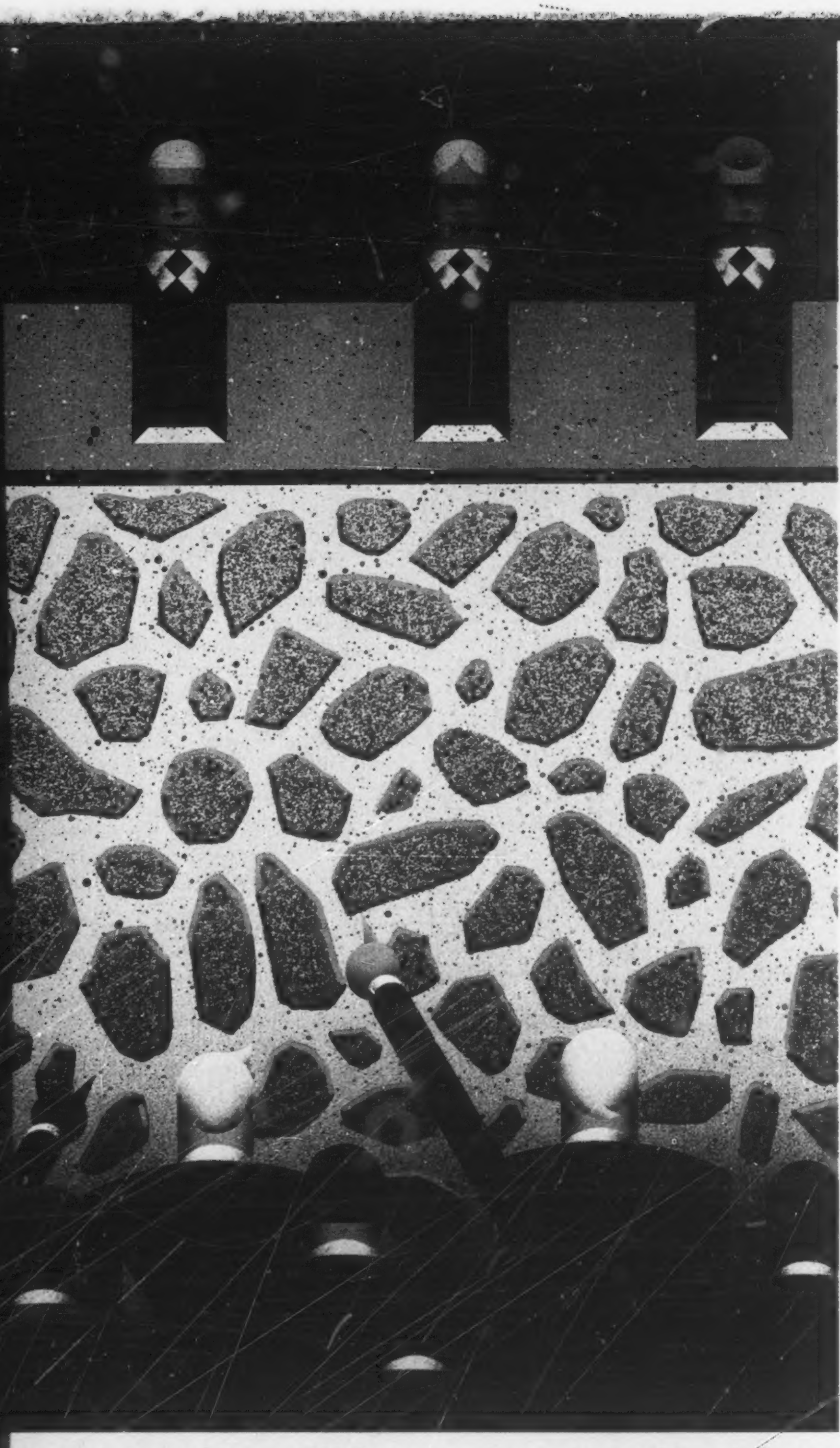
Europe's top electronics companies are scrambling to build global empires. They realize that they must expand volume to achieve the economies of scale necessary to finance high-technology growth. With some markets shrinking and competition from the United States and Japan increasing, those businesses that don't look beyond their borders will wind up as also-rans. "The globalization of the technologies and markets which fall within our sphere of operations calls for a worldwide approach to product policy," says C.J. van der Klugt, president of N.V. Philips GL of the Netherlands.

European firms will get a major boost in their international expansion plans in 1992, when the financial and trade barriers between countries are torn down. This will give EEC firms immediate access to a market with more people than the U.S. and about the same gross national product. With the so-called "United States of Europe" less than four years away, many companies have begun to stake out their claims in their expanding home territory.

Britain's The Plessey Company Plc, for example, has formed an International Development Group to, in the words of chairman Sir John Clark, "address urgently and vigorously the opportunities presented by this huge new market" and, like others, expand its ties with neighboring companies; in Plessey's case, Elettronica of Italy. "The year 1992 will be a watershed for industry throughout Europe," says Clark. "It will have profound effects on industrial companies."

But many Europeans worry that eliminating internal borders to allow free trade within the Common Market won't be enough. As a result, leading electronics companies may want to build higher walls to keep out non-European products. This worries Peter McPherson, deputy secretary of the U.S. Treasury Department, who is concerned that "an intensification of protectionism" could follow the restructuring.

At least some European firms are expected to lobby for tariffs, quotas and other trade restrictions to keep others out of the post-1992 Euromarket. Philips, for example, wants the EC action to block Japan from flooding the market with color televisions. Philips has scars from previous wars with the Japanese, notably in video cassette recorders. Philips virtually invented VCRs, but the Japanese came out with a competing standard and Philips had to toe their line. It's not all bad news for outsiders, though. Foreign companies located within the EC borders and those with European partners stand to benefit from the change to a Euromarket. (See related story in this issue on how



Jose Cruz

to do business in post-1992 Europe.)

In the accompanying tables, ELECTRONIC BUSINESS has ranked the top European electronics companies. This exclusive report is based on careful analysis of the financial statements of the largest companies doing business in Europe. Leading the list are Philips, IBM and Siemens. IBM Europe is consolidating its position as a strong, local company. Philips and Siemens are dramatically restructuring operations to survive in the changing marketplace.

Europe is not without its success stories. Still, much remains to be done if electronics companies want to make the most of the enlarged internal market. A controversial McKinsey & Co. report, published in July, compares British electronics companies with other European, U.S. and Japanese firms, and goes as far as saying that British electronics companies will not "survive" against Japanese, U.S. and some Western European competitors unless they radically change their current strategies.

The report criticizes Britain's electronics sector for relying too much on slow-growing defense and telecommunications business for revenue and also for not having expanded enough either in Europe or other international markets. "British electronics companies must invest to produce the critical mass necessary to be viable competitors in their chosen global markets," says Adair Turner, coauthor of the McKinsey report titled: "Performance and Competitive Success: Strengthening Competitiveness in the U.K. Electronics Industry."

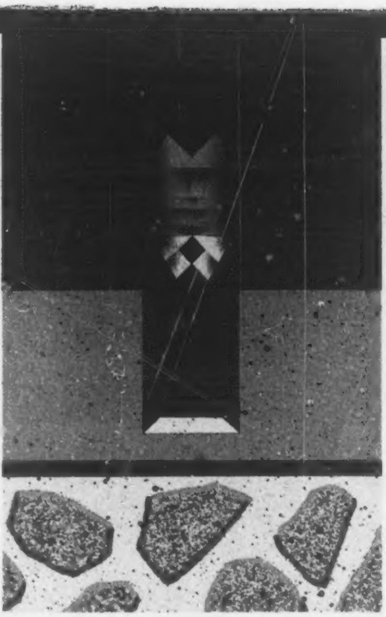
The probability of a significant improvement in Britain's competitive performance — or even the survival of British electronics — looks dim unless major changes are made. The report, for instance, shows that, as a whole, British electronics companies have lost market share even in their home market. In 1976, they accounted for almost half of Britain's sales. By 1986, however, this figure had declined to less than a third.

International rivals

In addition to losing ground in their own home market, they haven't expanded internationally as much as their foreign rivals. As a result, in McKinsey's view, U.S., Japanese and some Western European companies — such as Philips, Thomson-CSF, L.M. Ericsson and Ing. C. Olivetti & Co. — are better prepared to take advantage of the new opportunities of the soon-to-be-borderless Europe. These companies already are present in many of the individual EC markets and have, or are building, management structures suited to running global organizations.

McKinsey argues that some big U.S., Japanese and other Western European companies already generate a larger proportion of their home sales outside their home markets and are truly global companies. Meanwhile, British electronics companies, other than perhaps Racal Electronics and British Aerospace Plc, have not taken a long-term approach and built up their international organizations.

Holland's Philips, for example, sells 93.3% abroad; America's Rank Xerox sells 84.3% outside its home market; Sweden's Ericsson, 78%; Japan's Sony Corp., 70.5%; Italy's Olivetti, 65.7%; and France's Thomson, 60%. Britain's two exceptions, British



Aerospace and Racal, sell 66% and 60%, respectively, outside their home markets. Germany's giant Siemens AG, meanwhile, could take a lesson from others: It sells only 50% of its product in foreign markets. (Siemens is dramatically changing its strategy, see accompanying story.)

Doomsday scenario

London analysts do not all concur with McKinsey's doomsday scenario. In defense of British electronics companies' slow expansion into other EC countries, analysts point out it is a difficult task to find partners on the continent and that it takes time. "Europeans on the continent are very difficult to acquire," for example, says Miles Saltiel, electronics analyst with Hoare Govett, a London brokerage house. "You need long-term relationships and a lot of them have restricted share practices. A British company can't just go in there and do a hostile takeover."

At least one British firm targeted in the report's criticism, is currently reorganizing. Britain's General Electric Co. (GEC, no relation to the U.S. General Electric), which has operated with 120 independent subsidiaries, is centralizing control to ensure the convergence of new technologies. "So much of McKinsey's report seems to be aimed at GEC without specifically saying so," says Philip Hughes, chairman of Logica Plc, the British software house. "And the approach of having very decentralized development activities does make it very difficult to launch strategic initiatives."

Overpowering tough competitors abroad is proving a difficult task for some of the big European electronics companies —even those that are ahead of the game, relative to the British. Price pressures in the consumer electronics sector and competition from low-cost producers such as the Koreans have forced the major European companies to merge or be acquired. Last year, England's Plessey and GEC combined their strengths in telecommunications; Plessey expanded its stake in Elettronica to 49%; and Sweden's Asea AB and West Germany's BBC Brown Boveri merged the worldwide electrical engineering activity. It is essential "to utilize the global economies of scale" and focus on "growth ambitions in Europe and transoceanic countries," according to Percy Barnevik, Asea president and CEO.

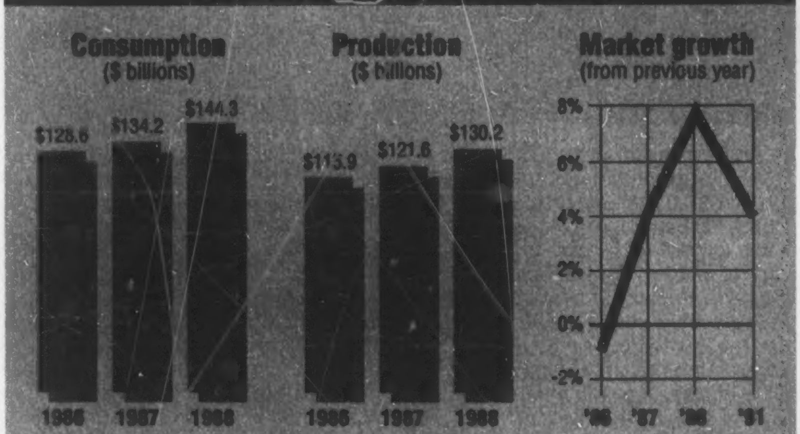
"The restructuring of the European market could possibly lead to an intensification of protectionism"

Meanwhile, Philips, which employs 340,000 worldwide, is facing the difficult task of going through a massive internal reorganization to cut costs by 800 million guilders (or $374 million — in late August, 2.14 guilders = $1) this year. In Europe, Philips says it will cut middle management by 20,000 people. During the next five to 10 years, it will close 70 European plants. Philips has already laid off 6,000 European employees and expects between 4,000 and 14,000 more job losses. Like GEC, Philips in the past relied on fiercely independent national subsidiaries. As part of the move to tighten control over national organizations, Philips has just named Geerit Jeelof, formerly vice chairman of the board of management, to head its U.S. operation.

"Philips is a microcosm of the whole industry and a very good indicator of what's going on in other places," says Angela Dean, analyst at Robert Fleming Securities Ltd., a London brokerage house. For example, at the end of July, Philips' second quarter net profit plunged 44%, an unexpectedly poor showing which sent stock down. Many analysts had expected Philips' earnings to be about equal to last year's, at 818 million guilders, or $382 million. Philips is Western Europe's biggest maker of semiconductors and consumer electronics products. Turnover has fallen steadily since 1985 and profit margins in the 1980s are not what they were in the 1960s.

"Our major task is to find an answer to what is the most pressing problem in consumer electronics, and that is constant price erosion," says Jan Timmer, Philips board member responsible for consumer electronics. "We have two to three years to know whether Philips will be able to make it in consumer electronics." Philips blames Japanese and Korean dumping. But, contends Pat Meagher-Davis, European electronics analyst with James Capel and Company, in London: "Antidumping measures

European electronics industry



U.S. dollars at 1986 exchange rates

Source: BEP Data Services Inc.

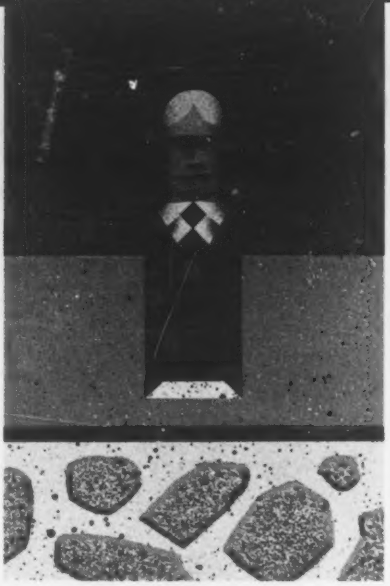
wouldn't solve the problem, it would only buy them time."

Philips, meanwhile, is rationalizing production, closing European plants and transferring manufacturing to the Far East. Executives say this shift will continue. Philips says survival depends on taking advantage of economies of scale and becoming a low-cost producer. The Dutch giant already has 27,000 employees and 25 plants in Japan, Hong Kong and other Asian countries and plans to shift more production there, as well as to Mexico. In Asia, Philips already manufactures black-and-white televisions, radios and video cassette recorders, which it sells worldwide. Philips also has plans to expand product development and engineering activities in the Far East.

Computer firms hold out

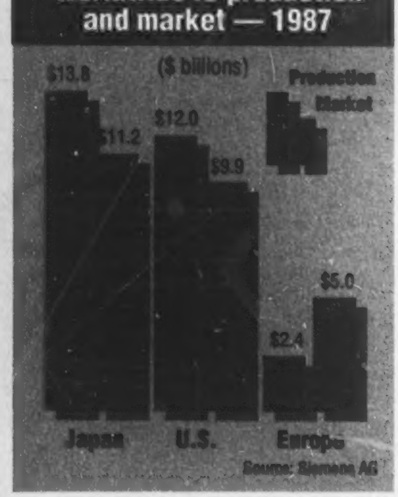
Despite this flurry of activity around the world, the majority of European computer makers are staying closer to home for the time being, although some of the larger players like Siemens are likely to increase their size and expand in European markets and, eventually, the United States. Others, like West Germany's Nixdorf Computer AG are, however, eyeing the world markets — with some success.

"It is going to get very hot in the computer sector, where not much restructuring has happened yet, and life is quite difficult," says Dean of Robert Fleming. "Too many companies are competing in a market that is dominated by United States suppliers." American computer companies remain strong market leaders in the European market, according to Dataquest. IBM has 56% of the European market in corporate resource computers (computers which cost more than $1 million). Digital Equipment Corp. is the leader in business unit computers with 20% of the European market (computers which cost between $75,000 and $250,000).



The post-1992 Euromarket will have more people than the U.S. and about the same gross national product

Worldwide IC production and market — 1987



Source: Siemens AG

Eventually, industry observers say, European computer companies will reorganize through mergers and acquisitions. Margins are being squeezed, market growth has slowed and most European companies are small relative to the giant United States firms. "We will see a lot of M&A activity — especially between hardware and software companies," says Meagher-Davis. "And a lot of those companies are cheap."

According to Meagher-Davis, European companies should be well placed to take advantage of what she calls the " 'microcomputer application.' You can't sell people just a box anymore, you have to sell them the total solution," she says. "Unlike the U.S. companies, European companies — Nixdorf is a prime example — have grown up that way." Some consolidation has already taken place between suppliers of hardware.

In January of last year, Siemens and BASF combined their IBM-compatible mainframe businesses to create Comparex, with sales of $500 million. And in March 1987, France's Groupe Bull, the United States' Honeywell Inc. and Japan's NEC Corp. created an organization with sales worth $2.1 billion. Britain's STC, which bought ICL, the British computer company, is currently looking for software houses to buy in West Germany.

As European companies restructure to secure their soon-to-be-expanded European home market, analysts also predict they will become more active in the U.S. market. In July, Siemens, the German electronics concern, signed an agreement to acquire a majority interest in Allied-Signal Inc.'s Bendix automotive electronics group for some $250 million. In the last few months, Siemens has set up ventures with Intel Corp. in microcomputers; Advanced Micro Devices Inc. in telecommunications and semiconductors; and Westinghouse Electric Corp. in factory automation and industrial controls.

According to analysts, there have been few moves by either U.S. or Japanese companies to acquire European firms. The United States' General Electric Co. did, however, take on Thomson-CGR, Thomson's medical systems business, as part of a deal whereby Thomson acquired GE's consumer electronics business. "If you look at computers and consumer electronics, the U.S. and Japanese companies are already significant competitors. The fight will be in public telecommunications. I don't think the European companies are badly placed," says Dean. "It suddenly may look a lot easier to the U.S. and Japanese companies to come into a big market, the European internal market. But there are opportunities on both sides."

The success story on everyone's mind is Ericsson. "For really good companies, the liberalization of telecommunications buying practices and the impending advent of 1992 will be a challenge," says Dean. "Just look what Ericsson did. It realized it couldn't survive in just Sweden, so it took advantage of the opening of the world telecommunications markets." Ericsson, which was an early leader in public switching systems, has captured 40% of the world cellular radio market. Others dream of similar success stories. ☐

Top European electronics companies

Rank	Company	Electronics sales ($ millions)	Electronics sales as a percentage of total sales	Total consolidated sales ($ millions)	Profit before tax as a percentage of sales	Profit after tax as a percentage of sales	Sales per employee	Profit before tax per employee
1	**Philips**	$18,825	72%	$25,968	1.9%	1.5%	$77,125	$1,488
2	**IBM**	18,332	34%	54,217	15.9%	9.7%	139,251	22,111
3	**Siemens**	15,098	55%	27,503	5.1%	2.5%	76,611	3,870
4	**CGE**	12,770	60%	21,208	3.9%	2.5%	96,620	3,808
5	**Thomson**	9.012	90%	10,014	4.4%	1.8%	116,438	5,069
6	**GEC**	5,756	61%	9,457	12.7%	8.1%	60,136	7,667
7	**Olivetti**	5,121	90%	5,688	7.3%	5.5%	NA	NA
8	**Ericsson**	4,238	83%	5,102	3.4%	2.3%	71,973	2,461
9	**Robert Bosch**	3,954	28%	14,092	6.9%	3.3%	87,340	5,987
10	**Xerox**	3,325	32%	10,320	8.1%	5.6%	104,209	8,482
11	**DEC**	3,253	35%	9,389	18.0%	12.1%	84,972	15,284
12	**STC**	3,147	93%	3,388	9.1%	6.0%	97,054	8,829
13	**STET**	3,113	26%	11,972	9.3%	7.2%	96,315	8,947
14	**Groupe Bull**	3,007	100%	3,007	1.1%	1.2%	114,169	1,260
15	**Nixdorf**	2,817	100%	2,817	6.5%	5.2%	95,687	6,238
16	**British Telecom**	2,805	16%	17,346	22.5%	14.3%	73,125	16,456
17	**Hewlett-Packard**	2,667	33%	8,090	11.9%	8.0%	98,659	11,732
18	**Unisys**	2,400	25%	9,713	9.8%	6.0%	105,004	10,243
19	**AEG**	2,333	36%	6,478	0.7%	0.0%	80,972	576
20	**Sony**	2,290	22%	10,347	5.1%	2.6%	171,025	8,783
21	**Matsushita**	2,233	6%	34,839	8.9%	3.4%	259,632	23,232
22	**Plessey**	2,216	100%	2,216	13.2%	9.1%	73,512	9,725
23	**Racal**	2,113	91%	2,328	10.1%	6.6%	72,970	7,370
24	**Canon**	2,058	30%	6,753	4.1%	1.4%	179,984	7,415
25	**NCR**	1,797	32%	5,641	13.5%	7.4%	90,979	12,297
26	**Nokia**	1,499	47%	3,174	9.0%	6.0%	NA	NA
27	**Grundig**	1,524	100%	1,524	4.9%	3.5%	78,241	3,844
28	**Thorn EMI**	1,352	26%	5,201	7.4%	4.8%	81,268	5,995
29	**Schlumberger**	1,300	30%	4,402	14.1%	11.4%	88,040	12,371
30	**Motorola**	1,200	18%	6,707	6.2%	4.6%	68,649	4,258
31	**Ferranti**	1,121	80%	1,400	8.3%	5.6%	56,414	4,666
32	**Control Data**	1,119	33%	3,367	1.7%	0.7%	97,580	1,664
33	**Bayer**	1,111	5%	20,635	8.3%	4.2%	125,517	10,361
34	**Mannesmann**	1,083	12%	9,253	1.7%	0.8%	81,685	1,365
35	**Honeywell**	1,005	15%	6,679	6.2%	3.8%	84,676	5,222

NA = Not available

Electronics sales: Represents ELECTRONIC BUSINESS' estimate of the revenue earned by each company from the sale of electronics products.

The figure shown is based on the latest available completed fiscal year, thus a variety of accounting periods are represented.

Similarly, the electronics sales and other financial information have been converted to dollars using an exchange rate that consists of the average rate during each company's fiscal year.

For European companies, the figure shown is their worldwide sales of electronics products, including those manufactured and sold outside Europe: for non-European companies the figure estimates their electronics sales in Western Europe only.

Electronics as a percentage of total sales: Indicates the proportion of electronics products within the total consolidated sales of all the products of the company. For firms not European owned, the percentage relates to their electronics sales in Western Europe as a percentage of total consolidated worldwide sales.

Profit after tax per employee	Fixed assets per employee	Investments as a percentage of sales	Return on gross capital employed	R&D as a percentage of sales	Capital expenditures as a percentage of sales	Current ratio	Fiscal year ended	Country of origin
$1,182	$27,048	16.0%	3.2%	8.3%	7.7%	1.49	12/87	Netherlands
13,505	58,873	18.0%	17.1%	10.0%	7.9%	2.32	12/87	U.S.
1,900	19,989	21.3%	5.9%	12.1%	9.2%	3.73	9/87	West Germany
2,367	14,624	11.7%	7.5%	7.8%	3.9%	1.28	12/87	France
2,057	19,555	14.7%	8.4%	6.3%	8.4%	1.14	12/87	France
4,882	8,930	17.1%	20.8%	12.1%	5.0%	2.11	3/88	Britain
NA	NA	NA	NA	0.7%	NA	NA	12/87	Italy
1,633	15,057	14.8%	5.2%	9.9%	4.9%	2.02	12/87	Sweden
2,839	13,905	13.6%	18.0%	5.6%	7.9%	2.08	12/87	West Germany
5,836	25,416	16.1%	11.0%	7.0%	9.1%	1.56	12/87	U.S.
10,293	19,252	18.7%	26.0%	10.8%	8.0%	3.40	6/87	U.S.
5,809	15,582	14.2%	25.0%	8.5%	5.7%	1.70	12/87	Britain
6,931	191,272	NA	NA	NA	35.8%	NA	12/87	Italy
1,423	39,737	21.1%	1.8%	8.6%	12.5%	1.60	12/87	France
4,985	29,278	23.4%	9.7%	9.4%	14.0%	2.36	12/87	West Germany
10,475	87,234	25.1%	19.4%	1.9%	23.2%	0.90	3/88	Britain
7,854	28,390	17.4%	18.9%	11.1%	6.3%	2.01	10/87	U.S.
6,249	22,929	13.6%	24.3%	6.1%	7.4%	1.33	12/87	U.S.
0	12,354	13.3%	1.3%	8.0%	5.4%	4.38	12/87	West Germany
4,390	50,942	18.2%	10.7%	8.9%	9.3%	1.14	3/88	Japan
8,773	29,301	9.3%	12.9%	5.6%	3.6%	2.15	3/88	Japan
6,708	13,528	12.6%	21.4%	7.2%	5.3%	1.50	3/88	Britain
4,781	20,367	9.8%	19.3%	NA	9.8%	1.53	3/88	Britain
2,441	43,606	12.3%	6.6%	5.8%	6.5%	1.73	12/87	Japan
6,763	17,068	13.2%	33.7%	6.3%	6.9%	1.72	12/87	U.S.
NA	NA	NA	NA	NA	NA	NA	12/87	Finland
2,751	10,686	9.9%	19.9%	3.4%	6.5%	1.25	3/87	West Germany
3,893	24,828	14.2%	21.1%	1.1%	13.1%	1.09	3/88	Britain
10,051	33,407	14.3%	15.1%	8.0%	6.3%	1.66	12/87	Netherlands Antilles
3,153	23,838	17.6%	12.4%	7.8%	9.8%	1.62	12/87	U.S.
3,136	17,094	10.1%	15.6%	4.9%	5.2%	1.31	3/88	Britain
722	17,675	16.9%	4.3%	11.6%	5.3%	1.63	12/87	U.S.
5,218	34,962	13.1%	24.1%	6.2%	6.9%	1.26	12/87	West Germany
656	19,785	6.2%	4.0%	2.2%	4.0%	1.42	12/87	West Germany
3,216	17,454	9.0%	18.0%	4.3%	4.7%	1.24	12/87	U.S.

Fixed assets per employee: Shows the accumulated value (less depreciation) of land, buildings, plant, machinery, furniture and fittings (including rental equipment) that the company has invested per employee.

Investments as a percentage of sales: Adds together capital expenditures and research and development as a proportion of total consolidated sales.

Return on gross capital employed: Shows profit before taxes as a proportion of net working capital plus fixed assets and investment (for example, equity holdings and other assets, not capital expenditures).

Capital expenditures as a percentage of sales: Shows the amount of new investment in fixed assets during the year as a proportion of total consolidated sales.

Current ratio: Shows current assets as a proportion of current liabilities, giving a rough indication of the liquidity of the company.

Country or origin: Indicates the country in which the company is ultimately registered.

Source: ELECTRONIC BUSINESS

Sales-growth speedsters: Make way for a new generation

1987 was the year the workstation came of age, with Sun Microsystems topping the list of fastest growing companies

BY BRUCE C.P. RAYNER AND
BY LINDA STALLMANN

It should come as no surprise that Sun Microsystems Inc. is the top-growth electronics company for 1987. With a five-year compounded growth rate of 474%, the $537 million workstation company sets a new record in the ELECTRONIC BUSINESS survey of the 100 fastest growing companies, now in its fourth year. By most accounts, Sun is destined for the billion-dollar club by the end of 1988.

Part of the reason for Sun's stellar performance is the growth of the workstation market itself. Computer-aided engineering workstations hardly existed at the beginning of the decade, but by 1987, reports market research firm Dataquest Inc., total worldwide revenue for workstations had reached $17 billion. The other component of Sun's growth comes from the corporate commitment to industry standards and open systems: "Everybody wants them," says Joseph Roebuck, Sun's vice president for sales. This commitment has earned Sun a 33% market share in 1987, up from 20% in 1986, a gain that Roebuck characterizes as "phenomenal."

But Sun is not the only benefactor of the workstation boom: fifth-ranked Mentor Graphics Corp., maker of engineering design systems, posted record sales and profits in 1987; 12th-placed Apollo Computer Inc., one of Sun's main competitors, has had five-year compounded growth at just under 100%; and CAE vendor Daisy Systems Corp., 15th on the list, boosted sales for a five-year average of 85.7%, despite its recent slow growth and losses in both 1986 and 1987. Gerard Langeler, president of Mentor, acknowledges that demand for workstations has contributed to his company's success, but insists that software is also important. "There is no workstation market without the applications to run on them," he says.

Top 10 fastest growing companies

1987 rank	Company	Market	5-year sales growth	Fiscal 1987 sales ($ millions)
1	**Sun Microsystems**	Workstations	474.4%	$537.5
2	**Lotus Development**	PC software	369.2%	395.6
3	**AST Research**	Boards and PCs	249.5%	206.0
4	**Iomega**	Floppy disks	185.2%	89.4
5	**Mentor Graphics**	CAE systems	164.1%	221.8
6	**MiniScribe**	Rigid disks	135.1%	362.5
7	**Symbolics**	AI systems	125.0%	103.8
8	**Oracle**	Database software	121.3%	131.3
9	**LSI Logic**	Gate array chips	121.0%	262.1
10	**Wyse Technology**	Terminals and PCs	102.9%	260.0

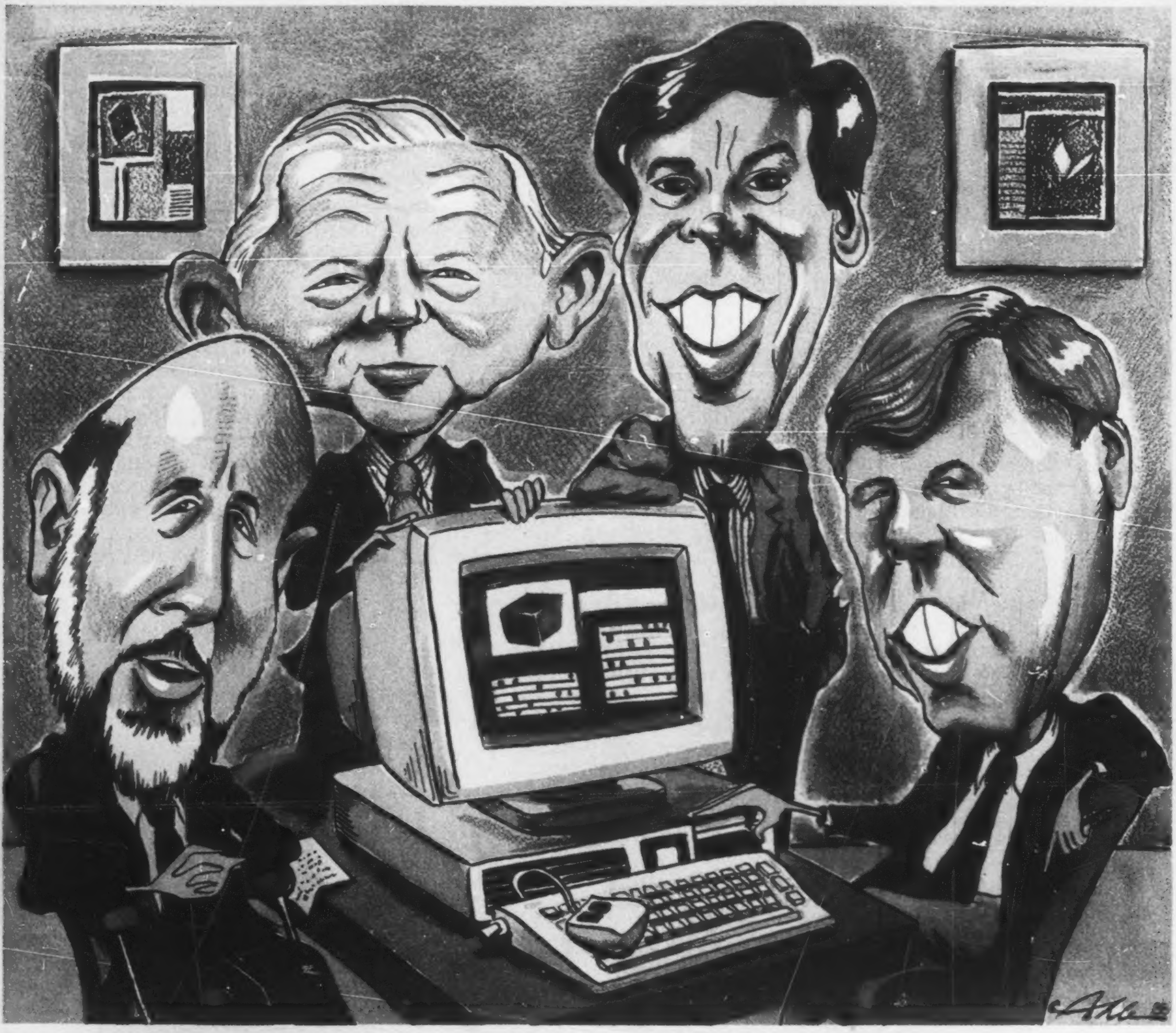
Source: ELECTRONIC BUSINESS

Just because workstation makers are in a fast-paced industry does not mean they have a monopoly on growth. Software, personal computers, chips and peripherals all are represented in the top echelons of the ELECTRONIC BUSINESS growth list. In fact, when taken as an industry segment, software was the leading performer in 1987. Sales of software grew at a rate of 64.3%, while profits grew at 84.6%. Second-ranked Lotus Development Corp., maker of the 1-2-3 database program, beat the average by over five times, posting an average sales growth rate of 369%. Peripherals makers came second, with average sales growth of 47.4%.

"I think the No. 1 reason for growth," admits Q.T. Wiles, chairman of sixth-placed MiniScribe Corp., a $362 million maker of rigid disk drives, "is that we are in a fast-growing industry." Also important are good management — MiniScribe employs a divisionalized style as opposed to a functional management style — tight cost control and being market-, not technology-driven, he adds. MiniScribe was at the top of the list last year, posting 369.5% average growth.

Calling California home

One significant trend gleaned from this list is the fact that 41 of these companies call California home. The number has been slowly but steadily inching up over the years. The closest competitor is Massachusetts, with 14 resident companies. In the future,



Driven by design: Heading some of the fastest growing companies are, from left: Daisy's Norman Friedmann; Apollo's Thomas Vanderslice; Mentor's Thomas Bruggere; and Sun's Scott McNealy

look to Texas to spawn high-growth companies. *Inc. Magazine* recently ranked Austin, Texas, the fastest growing city in the United States, partly because it won the sweepstakes to woo the Sematech semiconductor industry consortium. Also, Houston has started a campaign to become the next aerospace capital of America, after Southern California.

As with most previous years, the common thread in the top-growth companies is youth. In the top 10 this year, the oldest entrant is eighth-ranked Oracle Corp., a database management software company formed a decade ago. All other companies were established in the 1980s.

In order to qualify for ELECTRONIC BUSINESS' top 100 fast-growth list, a company must have reported sales for the past six years, with 1987 sales reaching at least $80 million. Also, the company must be U.S.-based and publicly held, with at least 70% of its total sales in electronics.

The six-year sales figure criterion was the disqualifier for Compaq Computer Corp. Compaq, the second-largest business personal computer maker in the world, behind IBM, was formed in 1982 but did not start shipping product until January 1983. It broke a first-year sales record by pulling in $111 million and has not looked back since. In 1987 the company nearly doubled its 1986 revenue by selling $1.2 billion worth of computers.

Michael Swavely, Compaq's vice president for sales, puts the company's performance down to the fact that Compaq has always considered itself a large company, even as a start-up. "In our part of the industry, you have to be a large company to compete," Swavely says. For 1988, he expects the company to outpace the forecast industry growth rate of 20%.

While growth is by definition faster when the company is just starting out, there are 12 billion dollar companies that make an appearance in the ELECTRONIC BUSINESS fastest growing 100: leading the pack is $2.7 billion Apple Computer Inc., at No. 41. Between heavy hitters Digital Equipment Corp. and Unisys Corp., it was a close call for 71st and 72nd place. Both Digital and Unisys are players in the workstation market, with DEC producing its own boxes and Unisys reselling the Sun system.

Where's IBM?

One mega-company conspicuous by its absence is IBM. For the past few years, Big Blue has been steadily climbing from 88th place in 1985 to 76th place last year. But because of lagging sales growth last year, IBM's 1987 five-year growth rate fell to

Dorothy Ahle

9.5% for the year, down from its 1986 figure of 12%. But this slowing growth figure is deceptive. In total, IBM boosted sales by $2.96 billion last year, an enviable figure for any company that made the list.

The key to growth, say top performers, is a combination of elements: being young means you are aggressive and that is essential; having a good distribution system means product gets to market faster; an ability to differentiate yourself from the pack technically helps in the battle for market share; a willingness to take some calculated — and some not so calculated — risks usually accelerates growth; and being in the right place at the right time always helps.

"Our growth is based on commonsense business tactics that keep the company going with a solid foundation," says Thomas Yuen, vice president for marketing and one of three founders of third-ranked AST Research Inc. Yuen has helped to guide AST from the add-in board business into a premier desktop computer systems house. Looking back on the transition period, Yuen says the biggest problem has been production capacity. "The capacity we initially forecast was way below what we can satisfy," he says.

Bernard Tse, chairman and chief executive of 10th-placed terminal maker Wyse Technology, says his strategy is no secret: "We picked a market that is enormous and tried to be very competitive." Tse claims both a cost advantage and a price advantage and "with a little bit of luck we have been able to grow very fast." But the company's luck may have limits. Seven-year-old Wyse is operating in a business that is actually shrinking, a worrisome phenomenon to a growth-oriented company. Dataquest estimates that the worldwide terminal market contracted to $3.5 billion last year, down from $3.9 billion in 1986. Still, Wyse grew its market share in 1987 from 14% to 17%, the only terminal maker to do so.

Two top-growth companies in less than robust health are Iomega Corp. and Symbolics Inc. Iomega, a maker of floppy disk drives, has reported a net loss of $36.7 million for calendar 1987 as a result of a decline in demand, substantial reduction in inventory level and slower than anticipated acceptance of the company's new 5.25 product. Symbolics, a manufacturer of symbolic processing systems for technical and artificial-intelligence workstations, reported a net loss of $25.5 million in fiscal 1987, ending June 30, and losses of $19.9 million for the first half of fiscal 1988. The company is in a restructuring mode to pare down operations.

1987's fastest-growing companies by segment

Software

	5-year sales growth	5-year profit growth	1987 rank
Lotus Development	369.2%	NM	2
Oracle	121.3%	124.7%	8
Ashton-Tate	71.3%	109.4%	17
Microsoft	69.8%	82.9%	18
Ultimate	42.1%	36.6%	34
Cullinet Software	28.8%	NM	47
Weighted average	**64.3%**	**84.6%**	

Peripherals

	5-year sales growth	5-year profit growth	1987 rank
Iomega	185.2%	NM	4
MiniScribe	135.1%	NM	6
Wyse Technology	102.9%	NM	10
Seagate Technology	88.3%	82.3%	14
Archive	69.7%	NM	19
QMS	67.4%	38.5%	[illegible]
Quantum	54.6%	116.3%	2[illegible]
Micropolis	54.3%	218.6%	2[illegible]
Lee Data	53.0%	34.6%	2[illegible]
Intelligent Systems	46.0%	NA	30
Emulex	44.9%	10.8%	31
Xidex	42.5%	NM	33
Priam	34.0%	NM	42

Peripherals (continued)

	5-year sales growth	5-year profit growth	1987 rank
Cipher Data Products	25.1%	12.7%	55
Applied Magnetics	18.0%	9.7%	77
Printronix	13.8%	NM	93
Weighted average	**49.9%**	**33.3%**	

Computer-based systems

	5-year sales growth	5-year profit growth	1987 rank
Mentor Graphics	164.1%	NM	5
Daisy Systems	85.7%	NM	15
Mark IV Industries	67.6%	72.3%	21
Intergraph	32.7%	40.0%	44
Ask Computer Systems	31.6%	24.3%	46
Data Card	26.9%	-15.2%	53
ISC Systems	22.1%	-4.2%	60
Evans-Sutherland	20.1%	8.5%	64
Recognition Equipment	18.7%	NM	75
Coherent	14.6%	NM	85
Measurex	14.0%	NM	89
Computer Consoles	13.4%	5.3%	96
Weighted average	**27.9%**	**42.7%**	

(Continued)

NA = Not available
NM = Not meaningful, company had a loss in one of the base years

1987's fastest-growing companies by segment

Computers	5-year sales growth	5-year profit growth	1987 rank
Sun Microsystems	474.4%	NM	1
Symbolics	125.0%	NM	7
Stratus Computer	101.9%	NM	11
Apollo Computer	98.2%	134.3%	12
Kaypro	80.9%	NM	16
SCI Systems	43.8%	31.2%	32
Cray Research	37.2%	50.6%	38
Apple Computer	35.5%	28.8%	41
Telex	32.3%	45.8%	45
Tandem Computers	27.1%	28.7%	51
Amdahl	26.6%	96.3%	54
Altos Computer Systems	24.7%	11.1%	56
Wang Laboratories	19.6%	NM	67
DEC	19.3%	22.2%	71
Unisys	18.9%	33.4%	72
Prime Computer	17.1%	7.6%	80
Tandy	13.5%	1.6%	94
Weighted average	**21.6%**	**20.6%**	

Semiconductors	5-year sales growth	5-year profit growth	1987 rank
LSI Logic	121.0%	NM	9
Micron Technology	94.4%	NM	13
Western Digital	69.3%	NM	20
VLSI Technology	52.0%	NM	28
Silicon Systems	38.5%	14.3%	36
Burr-Brown	19.8%	16.3%	65
Advanced Micro Devices	19.5%	NM	68
Analog Devices	16.3%	13.6%	82
Intel	16.2%	52.5%	83
Siliconix	15.3%	40.2%	84
Weighted average	**22.4%**	**43.2%**	

Distributors	5-year sales growth	5-year profit growth	1987 rank
Anthem Electronics	38.5%	27.0%	37
Marshall Industries	19.4%	NM	70
Pioneer-Standard Electronics	17.5%	-4.4%	79
Wyle Laboratories	13.4%	NM	95
Weighted average	**18.9%**	**144.9%**	

Communications	5-year sales growth	5-year profit growth	1987 rank
Digital Communications Assoc.	66.5%	107.0%	23
Regency Electronics	49.5%	36.8%	29
Timeplex[1]	35.5%	NA	39
DSC Communications	35.5%	16.7%	40
Micom Systems	27.8%	9.0%	49
Bolt Beranek and Newman	27.6%	NM	50
General DataComm Industries	27.0%	NM	52
Dynatech	23.7%	30.3%	58
Cincinnati Microwave	22.9%	17.6%	59
ADC Telecommunications	21.8%	26.9%	61
Avantek	20.6%	4.3%	63
Motorola	12.1%	12.6%	100
Weighted average	**15.8%**	**15.1%**	

Defense	5-year sales growth	5-year profit growth	1987 rank
Electrospace Systems	28.2%	18.3%	48
Loral	19.6%	17.2%	66
Logicon	18.9%	14.1%	73
AEL Industries	18.8%	52.8%	74
Varo	13.9%	8.5%	91
Weighted average	**20.0%**	**17.3%**	

Capital equipment	5-year sales growth	5-year profit growth	1987 rank
LTX	20.7%	NM	62
Teradyne	16.5%	NM	81
Gerber Scientific	14.2%	44.0%	87
Hewlett-Packard	14.1%	11.0%	88
Applied Materials	13.9%	NM	90
Nicolet Instruments	13.3%	3.0%	97
Weighted average	**14.2%**	**10.6%**	

Components (other than semiconductors)	5-year sales growth	5-year profit growth	1987 rank
Molex	18.5%	15.9%	76
AVX	17.7%	38.8%	78
AMP	13.3%	16.0%	98
Cherry	12.3%	-8.5%	99
Weighted average	**14.1%**	**16.2%**	

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[1] Acquired by Unisys Corp. Jan 22, 1988

NA = Not available

NM = Not meaningful, company had a loss in one of the base years

(Continued)

1987's fastest-growing companies

1987 rank	Company	5-year sales growth	Fiscal 1987 sales ($ millions)	Fiscal 1987 profits ($ millions)	Fiscal year ended	Location
1	**Sun Microsystems**	474.4%	$537.5	$36.3	6/87	Mountain View, Calif.
2	**Lotus Development**	369.2%	395.6	72.0	12/87	Cambridge, Mass.
3	**AST Research**	249.5%	206.0	13.0	6/87	Irvine, Calif.
4	**Iomega**	185.2%	89.4	-36.7	12/87	Roy, Utah
5	**Mentor Graphics**	164.1%	221.8	20.3	12/87	Beaverton, Ore.
6	**MiniScribe**	135.1%	362.5	31.1	12/87	Longmont, Colo.
7	**Symbolics**	125.0%	103.8	-25.5	6/87	Cambridge, Mass.
8	**Oracle**	121.3%	131.3	15.6	3/87	Belmont, Calif.
9	**LSI Logic**	121.0%	262.1	10.7	12/87	Milpitas, Calif.
10	**Wyse Technology**	102.9%	260.0	18.1	3/87	San Jose, Calif.
11	**Stratus Computer**	101.9%	184.2	19.4	12/87	Marlboro, Mass.
12	**Apollo Computer**	98.2%	553.7	21.7	12/87	Chelmsford, Mass.
13	**Micron Technology**	94.4%	91.2	-22.9	8/87	Boise, Idaho
14	**Seagate Technology**	88.3%	958.1	139.7	6/87	Scotts Valley, Calif.
15	**Daisy Systems**	85.7%	100.9	-16.3	9/87	Mountain View, Calif.
16	**Kaypro**	80.9%	105.6	-9.6	8/87	Solana Beach, Calif.
17	**Ashton-Tate**	71.3%	267.3	43.1	1/88	Torrance, Calif.
18	**Microsoft**	69.8%	345.9	71.9	6/87	Redmond, Wash.
19	**Archive**	69.7%	88.8	6.1	9/87	Costa Mesa, Calif.
20	**Western Digital**	69.3%	462.5	42.8	6/87	Irvine, Calif.
21	**Mark IV Industries**	67.6%	291.5	10.2	2/87	West Amherst, N.Y.
22	**QMS**	67.4%	119.4	8.7	9/87	Mobile, Ala.
23	**Digital Communications**	66.5%	181.4	27.0	6/87	Alpharetta, Ga.
24	**Emerson Radio**	56.0%	810.1	26.6	3/87	North Bergen, N.J.
25	**Quantum**	54.6%	120.8	8.8	3/87	Milpitas, Calif.
26	**Micropolis**	54.3%	288.3	27.2	12/87	Chatsworth, Calif.
27	**Lee Data**	53.0%	114.5	5.4	3/87	Minneapolis, Minn.
28	**VLSI Technology**	52.0%	172.0	8.1	12/87	San Jose, Calif.
29	**Regency Electronics**	49.5%	495.3	24.3	6/87	Indianapolis, Ind.
30	**Intelligent Systems**[1]	46.0%	163.0	NA	12/87	Norcross, Ga.
31	**Emulex**	44.9%	103.8	3.5	6/87	Costa Mesa, Calif.
32	**SCI Systems**	43.8%	552.9	16.0	6/87	Huntsville, Ala.
33	**Xidex**	42.5%	572.8	-44.5	6/87	Mountain View, Calif.
34	**Ultimate**	42.1%	172.9	13.8	4/87	East Hanover, N.J.
35	**Data Switch**	39.7%	96.9	2.3	12/87	Shelton, Conn.
36	**Silicon Systems**	38.5%	81.8	2.8	9/87	Tustin, Calif.
37	**Anthem Electronics**	38.5%	196.9	5.0	12/87	San Jose, Calif.
38	**Cray Research**	37.2%	687.3	147.1	12/87	Minneapolis, Minn.
39	**Timeplex**[2]	35.5%	147.2	NA	6/87	Woodcliff Lake, N.J.
40	**DSC Communications**	35.5%	312.4	14.6	12/87	Plano, Texas
41	**Apple Computer**	35.5%	2,661.1	217.5	9/87	Cupertino, Calif.
42	**Priam**	34.0%	129.6	-41.3	6/87	San Jose, Calif.
43	**Network Systems**	33.5%	120.5	17.5	12/87	Minneapolis, Minn.
44	**Intergraph**	32.7%	641.1	69.9	12/87	Huntsville, Ala.
45	**Telex**	32.3%	840.7	77.9	3/87	Tulsa, Oklahoma
46	**Ask Computer Systems**	31.6%	98.3	8.0	6/87	Los Altos, Calif.
47	**Cullinet Software**	28.8%	174.9	-27.6	4/87	Westwood, Mass.
48	**Electrospace Systems**	28.2%	190.7	10.1	3/87	Richardson, Texas
49	**Micom Systems**	27.8%	196.7	12.2	3/87	Simi Valley, Calif.
50	**Bolt Beranek and Newman**	27.6%	233.8	-8.0	6/87	Cambridge, Mass.

[1] Estimate by INP 2/22

[2] Acquired by Unisys Corp. Jan. 22, 1988

NA = Not available

(continued)

1987's fastest-growing companies

1987 rank	Company	5-year sales growth	Fiscal 1987 sales ($ millions)	Fiscal 1987 profits ($ millions)	Fiscal year ended	Location
51	**Tandem Computers**	27.1%	$1,035.5	$105.6	9/87	Cupertino, Calif.
52	**General DataComm Industries**	27.0%	200.6	0.8	9/87	Middlebury, Conn.
53	**Data Card**	26.9%	176.1	1.6	3/87	Minneapolis, Minn.
54	**Amdahl**	26.6%	1,505.2	142.0	12/87	Sunnyvale, Calif.
55	**Cipher Data Products**	25.1%	178.2	4.3	6/87	San Diego, Calif.
56	**Altos Computer Systems**	24.7%	153.9	9.7	6/87	San Jose, Calif.
57	**Diceon Electronics**	23.8%	111.1	9.5	9/87	Irvine, Calif.
58	**Dynatech**	23.7%	304.7	23.2	3/87	Burlington, Mass.
59	**Cincinnati Microwave**	22.9%	80.9	12.3	12/87	Cincinnati, Ohio
60	**ISC Systems**	22.1%	168.5	6.5	6/87	Spokane, Wash.
61	**ADC Telecommunications**	21.8%	166.9	15.3	10/87	Bloomington, Minn..
62	**LTX**	20.7%	120.6	-6.7	7/87	Westwood, Mass.
63	**Avantek**	20.6%	213.7	11.6	12/87	Santa Clara, Calif.
64	**Evans-Sutherland**	20.1%	134.4	14.7	12/87	Salt Lake City, Utah
65	**Burr-Brown**	19.8%	140.5	4.3	12/87	Tucson, Ariz.
66	**Loral**	19.6%	690.0	57.5	3/87	New York, N.Y.
67	**Wang Laboratories**	19.6%	2,836.7	-70.7	6/87	Lowell, Mass.
68	**Advanced Micro Devices**	19.5%	997.1	-48.1	12/87	Sunnyvale, Calif.
69	**Diasonics**	19.5%	267.6	15.2	12/87	South San Francisco, Calif.
70	**Marshall Industries**	19.4%	286.6	5.1	5/87	El Monte, Calif.
71	**DEC**	19.3%	9,389.4	1,137.4	6/87	Maynard, Mass.
72	**Unisys**	18.9%	9,712.9	578.0	12/87	Detroit, Mich.
73	**Logicon**	18.9%	204.8	6.1	3/87	Torrance, Calif.
74	**AEL Industries**	18.8%	108.4	3.3	2/87	Landsdale, Pa.
75	**Recognition Equipment**	18.7%	264.7	11.2	10/87	Dallas, Texas
76	**Molex**	18.5%	386.8	43.4	6/87	Lisle, Ill.
77	**Applied Magnetics**	18.0%	211.9	14.2	9/87	Goleta, Calif.
78	**AVX**	17.7%	271.9	15.8	12/87	Great Neck, N.Y.
79	**Pioneer-Standard Electronics**	17.5%	212.2	1.8	3/87	Cleveland, Ohio
80	**Prime Computer**	17.1%	960.9	64.8	12/87	Natick, Mass.
81	**Teradyne**	16.5%	377.7	-21.1	12/87	Boston, Mass.
82	**Analog Devices**	16.3%	370.4	18.7	10/87	Norwood, Mass.
83	**Intel**	16.2%	1,907.1	248.1	12/87	Santa Clara, Calif.
84	**Siliconix**	15.3%	122.5	3.9	12/87	Santa Clara, Calif.
85	**Coherent**	14.6%	159.0	-1.1	9/87	Palo Alto, Calif.
86	**Hadco**	14.6%	124.3	2.6	10/87	Salem, N.H.
87	**Gerber Scientific**	14.2%	223.9	21.1	4/87	South Windsor, Conn.
88	**Hewlett-Packard**	14.1%	8,090.0	644.0	10/87	Palo Alto, Calif.
89	**Measurex**	14.0%	227.4	26.8	11/87	Cupertino, Calif.
90	**Applied Materials**	13.9%	174.4	0.3	10/87	Santa Clara, Calif.
91	**Varo**	13.9%	95.3	3.5	4/87	Garland, Texas
92	**Zenith Electronics**	13.8%	2,362.7	-19.1	12/87	Glenview, Ill.
93	**Printronix**	13.8%	123.7	-4.9	3/87	Irvine, Calif.
94	**Tandy**	13.5%	3,452.2	242.3	6/87	Fort Worth, Texas
95	**Wyle Laboratories**	13.4%	368.0	5.8	1/88	El Segundo, Calif.
96	**Computer Consoles**	13.4%	148.4	9.6	12/87	Waltham, Mass.
97	**Nicolet Instruments**	13.3%	121.6	5.4	3/87	Madison, Wis.
98	**AMP**	13.3%	2,318.0	250.0	12/87	Harrisburg, Pa.
99	**Cherry**	12.3%	160.6	2.7	2/87	Waukegan, Ill.
100	**Motorola**	12.1%	6,700.0	308.0	12/87	Schaumburg, Ill.

Source: ELECTRONIC BUSINESS

The top R&D spenders in the electronics industry

R&D spending was up last year for the third straight year, as companies continue to accelerate their technology investments

BY DWIGHT B. DAVIS
and LINDA STALLMANN

Led by the software, capital equipment and minicomputer sectors, 100 of the top U.S. electronics firms pumped 8.6% of their sales revenue into research and development during 1987. Cullinet Software Inc. paced the pack, devoting more than a quarter (28.5%) of its $174.9 million in revenue to R&D. Last year's leader, Advanced Micro Devices Inc., dropped to second place, with 24.9% of its $997.1 million in sales so committed.

Actual R&D expenditures at the 100 companies jumped from $13.0 billion in 1986 to $15.8 billion last year, a whopping 21.5% increase. This leap came despite a more modest 12.6% growth in sales, which climbed from $162.1 billion to $182.5 billion over the same period.

Driving the industry's continuing commitment to R&D have been a combination of factors, including foreign competition, increasing technological complexity and short product life cycles. "The rate of creation of new products is very high in the electronics industry," notes Todd Hixon, vice president of the Boston Consulting Group. "As a result, these companies have to spend continuously on research and development."

This analysis is seconded by Austin Mayer, director of investor relations at Sun Microsystems Inc., which ranked 14th in percentage of revenue devoted to R&D. "Our products typically have an 18 to 24 month life cycle, which means that we're constantly replacing our line," Mayer says. "We always have several generations of products under development simultaneously, which takes a lot of money and effort."

As a subset of the overall economy, electronics far surpasses most other industry sectors in its percentage of revenue spent on R&D. U.S. companies overall devoted only 3.4% of their 1987 sales revenue to R&D, according to *Business Week* magazine, or less than half the percentage of the electronics firms.

"The pure play electronics companies such as the big CPU vendors and the semiconductor firms are very committed to research and development," says analyst Hixon. "Many of the big industrial companies, on the other hand — even firms such as General Electric, that have electronics divisions — have come to the conclusion that it's better to take advantage of horizontal mergers with other companies than to invest a lot in R&D." (To qualify for the ELECTRONIC BUSINESS R&D ranking, companies must derive at least 70% of their revenue from electronics-related sales and be included in the ELECTRONIC BUSINESS 200.)

Still, 1987 shortfalls in sales accounted for at least some of the high percentage of revenue spent at the top-ranked firms. Once R&D budgets are set and projects begun, it can be difficult to cut them back quickly, even if anticipated revenue doesn't materialize. Year-end figures may then reflect unexpectedly high percentages of revenue devoted to R&D.

AMD, for example, had planned to cut its 1987 R&D spending to about 20% of revenue, but softer than expected sales kept the percentage in the mid-20s. For 1988, however, the company is on track in its attempt to hold such spending at 20% of revenue, having cut back on some programs, such as SRAM development, and eliminated other projects entirely.

Even so, 20% spending represents far more than the industry norm, even within the relatively high-spending semiconductor sector, which devoted 9.5% of its 1987 sales to R&D. "Semiconductor companies are pursuing a technology that is not yet close to its limits," explains Hixon.

Foreign competition also plays an important role in this sector, according to AMD chairman and CEO W. Jerry Sanders III. "The U.S. microelectronics industry is in a crucial struggle to retain parity in semiconductor manufacturing with foreign competitors," he said recently, when announcing plans for a new manufacturing facility. "State-of-the-art research and development facilities are essential as the semiconductor industry moves rapidly into the submicron era."

In addition, U.S. chip makers have been forced into large R&D outlays as the lower ends of their product lines have achieved commodity status, according to Hixon. "As the Asian companies continue to take share in the commodity end of the market, the U.S. firms must look for advances in application-specific and other high-end products."

Nevertheless, at least two factors have worked to keep semiconductor R&D spending under control. The industry's average R&D expenditures dropped from 10.6% in 1986 to 9.5% last year, in part because industry-wide sales were extremely strong in 1987, despite softness in some industry segments. The monies earmarked for R&D last year therefore ended up accounting for a smaller percentage of overall revenue.

This trend may continue in 1988, says Bob Reed, chief financial officer at 12th-ranked Intel Corp. "We're having another good year," he says, "so it's possible that the percentage of revenue spent on R&D may drop, even though we will show a healthy increase in absolute spending." Intel will spend at least $300 million this year on R&D, Reed predicts, up from $260 million last year. "The key is to keep absolute spending growing at a steady pace," he maintains.

The second factor working to ease R&D costs in the semiconductor sector is the proliferation of design automation systems and other productivity tools, according to Reed. Such products "have been a phenomenal help in holding down costs," he says. Without the consequent boost in research productivity, Reed estimates that Intel would have spent $350 million to $400 million on R&D last year, not $260 million, to achieve the same results.

Closely linked to the semiconductor sector are the capital equipment companies, many of which produce the machines and processes used to fabricate and test memory and microprocessor chips. These firms spent an average of 11.2% of revenue on R&D in 1987, placing them second only to the high-spending software segment. Applied Materials Inc., ranked at No. 4, spent well above the capital equipment industry average last year, with 17.9% of its revenue going toward R&D, but chairman and CEO James C. Morgan expects his company to approach the sector norm in coming years.

R&D spending at top electronics companies increased 21.5% despite a more modest 12.6% growth in sales

"During the industry downturn we spent very heavily on new products in the etcher, ion implant, epitaxy and CVD [chemical vapor deposition] areas," he explains. "We're now spending on technology at a run rate of about $40 million a year, and in actual dollars we expect to spend more every year. But as a percentage of sales, we expect R&D to decline to about 10% to 12%, assuming we're spending $35 million or more in absolute dollars. The nature of our business is such that if you spend something in that order of magnitude you can get a lot accomplished."

Of Applied Materials' 1,700 worldwide employees, over 200 are directly involved in research and development, Morgan says. A corporate committee of key technology executives is responsible for reviewing product development, although Morgan ultimately oversees all technology projects. "We have about three pages of things I'd like to get to," he says, "and we review the list every six months." Morgan also notes that the company works closely with its customers, "so we can leverage our R&D in that way."

However, neither the semiconductor sector nor the capital equipment companies can match the software industry when it comes to percentage of sales spent on R&D. Software firms spent a whopping 12.4% of their 1987 revenue on R&D, up from 10.1% in 1986. Some of this rise came at the expense of earnings at some of the software companies.

First-ranked Cullinet, for example, suffered a loss of $27.6 million in 1987, caused in part by the company's large commitment to R&D spending. Cullinet devoted $50 million to R&D in 1987, up from $35.5

Leaders in R&D spending

	Total 1987 R&D expenditures ($ millions)	
1	IBM	$5,434.0
2	Digital Equipment	1,010.4
3	Hewlett-Packard	901.0
4	Xerox	722.0
5	Unisys	597.0
6	Motorola	524.0
7	Texas Instruments	428.0
8	GM Hughes Electronics	416.0
9	Control Data	389.0
10	NCR	356.6
11	Honeywell	289.8
12	Intel	259.8
13	Advanced Micro Devices	247.8
14	National Semiconductor	218.9
15	Wang Laboratories	212.4

	1987 R&D expenditures per employee	
1	Apple Computer	$34,206
2	Lotus Development	27,819
3	Cray Research	25,262
4	Amdahl	23,545
5	VLSI Technology	22,698
6	Ashton-Tate	22,388
7	Applied Materials	22,193
8	Microsoft	20,967
9	Cullinet Software	20,723
10	Mentor Graphics	20,149
11	LTX	19,919
12	Digital Communications	17,775
13	Altos Computer Systems	17,646
14	3Com	16,837
15	Sun Microsystems	16,637

	1987 R&D expenditures as a percentage of revenue	
1	Cullinet Software	28.5%
2	Advanced Micro Devices	24.9%
3	LTX	19.2%
4	Applied Materials	17.9%
5	VLSI Technology	17.8%
6	Teradyne	16.3%
7	Cray Research	15.8%
8	Analog Devices	15.1%
9	Lotus Development	14.8%
10	Tektronix	14.3%
11	Computer Consoles	14.0%
12	Intel	13.6%
13	GenRad	13.6%
14	DSC Communications	13.1%
15	Computer Associates	13.0%

Fiscal 1987 figures

Source: ELECTRONIC BUSINESS

million the previous year. "The increase was done by intent, even though we knew it would depress our earnings," says Jeff Papous, vice president for corporate marketing.

Cullinet needed to commit additional funds to R&D, Papous explains, because the company had acquired several companies in an attempt to broaden its product line beyond the IBM mainframe marketplace. "The acquisitions accelerated our time to market," he says, "but we needed to beef up our internal R&D to make all of the new products compatible with one another and with our existing line."

Papous says Cullinet is also spending heavily in R&D because of the firm's efforts to develop applications software to supplement its traditional systems software products. Nevertheless, the company's percentage of R&D spending will drop to about 19% of revenue this year, and should hold steady at that level, he says.

Although Cullinet experienced unique pressures in 1987 that pushed its R&D spending percentage above all other electronics companies, several shared aspects of the software industry worked to keep the sector as a whole at the top of the R&D list. "In a way, software companies are almost pure product development businesses," says analyst Hixon. "Their raw materials and manufacturing costs are negligible compared to other industry sectors, and the percentage of money spent on R&D is subsequently higher."

The company profile at ninth-ranked Lotus Development Corp. supports this perspective, given that approximately one-third of the firm's employees have some R&D association, according to Ed Belove, vice president for corporate R&D. But an unrelated factor is probably responsible for the software sector's 2.3% jump in spending from 1986 to 1987, he believes.

Platform proliferation

"From 1981 to 1986, many of us in the software industry had a single platform on which to build our products: the IBM PC and its compatibles," Belove notes. "Around 1986, however, all sorts of new platforms appeared, including OS/2 and Presentation Manager-based machines, Unix workstations, the Macintosh and, for us, mainframes. During 1987, we undertook a lot of efforts to develop products for these different platforms, and our expenses, subsequently, were high."

Companies with the fastest growth in R&D spending

R&D expenditures	Percentage growth from 1986	Total 1987 ($ millions)
Genicom	143.3%	$14.9
MiniScribe	131.7%	19.8
Sun Microsystems	127.0%	69.6
Maxtor	98.3%	11.8
Micropolis	94.5%	21.8
3Com	86.7%	9.3
Microsoft	85.5%	38.1
Lotus Development	79.6%	58.4
Compaq Computer	77.1%	47.1
Intelligent Systems	70.2%	6.5
BBN	65.4%	14.3
Computer Associates	58.1%	40.1
Wyse Technology	55.6%	13.9
Western Digital	51.6%	37.4
Amdahl	50.2%	178.9

Source: ELECTRONIC BUSINESS

Lotus' 14.8% R&D spending in 1987 was "probably a bit high for us," says Belove. The company doesn't set specific spending goals for R&D as a percentage of revenue, but Belove believes 10% would be closer to the desirable level. Still, he expects that this year's spending may continue at an elevated rate, in part because customers want compatibility among all the different types of machines now installed. Achieving such compatibility will require continued heavy R&D investments, Belove predicts.

Software firms don't yet have the productivity tools to keep costs down

In addition, software companies don't yet have the productivity tools that have helped the semiconductor industry hold its costs down, points out Martyn Roetter, manager of the information and telecommunications industry practice at Arthur D. Little. "CASE [computer-aided software engineering] tools have not yet fulfilled their promise," he says. "As a result, software development is still very people-intensive."

Other electronics industry sectors, such as the peripherals, communications, components and government groups, fall below the 8.6% industry spending average, but even the lowest ranked (5.4%) government sector surpasses the 3.4% average of all U.S. businesses. The reasons why these sectors trail others in the electronics industry are varied. In the case of the defense-dependent government sector, for example, reductions in DOD expenditures have kept R&D spending down.

In other cases, subcategories of companies within sectors have bucked their sectors' overall trends. One example is that of disk drive companies within the peripherals sector. Three of the top five companies ranked by the percentage increase in revenue spent on R&D from 1986 to 1987 were disk drive manufacturers.

This jump reflects the "law of diminishing returns" in this sector, says Robert Katzive, vice president of Disk/Trend Inc. "You can spend the same amount and be late in the marketplace, or you can spend more and keep up," the market researcher says. "And this industry isn't kind to latecomers."

Technological factors have also put pressure on disk drive companies to increase sales, Katzive says, with low-end vendors shifting to the small format 3.5-inch drives and high-end suppliers packing more capacity into their products. "Drives in the 380-megabyte and above range are not easy to design [or manufacture]," he notes.

In the future, it can be expected that electronics companies of all types will continue to outpace other industry sectors in R&D outlays.

"Looking at the total R&D expenditure is too crude a measure," Roetter says. "How much is spent on basic research? How much on design engineering? How much on product engineering?" he asks.

Noting the success that Japanese firms have achieved by concentrating resources on manufacturing engineering, Roetter believes that U.S. firms need to follow suit. "It makes no sense to spend lots of money developing advanced new products if there's no way to economically manufacture them," he concludes.

Top R&D spenders

1987 R&D rank	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Percentage change in expenditures from 1986	Fiscal 1987 revenue ($ millions)	Percentage change in revenue from 1986	Fiscal 1987 net income ($ millions)	Percentage change in net income from 1986	Fiscal year ended
1	**Cullinet**	28.5%	$49.9	40.4%	$174.9	-7.6%	-$27.6	NM	4/87
2	**Advanced Micro Devices**	24.9%	247.8	34.8%	997.1	73.1%	-48.1	NM	12/87
3	**LTX**	19.2%	23.2	7.5%	120.6	26.4%	-6.7	NM	7/87
4	**Applied Materials**	17.9%	31.2	26.7%	174.4	16.9%	0.3	-72.9%	10/87
5	**VLSI Technology**	17.8%	30.5	31.0%	172.0	54.0%	8.1	14,294.6%	12/87
6	**Teradyne**	16.3%	61.5	21.1%	377.7	23.4%	-21.5	NM	12/87
7	**Cray Research**	15.8%	108.8	24.1%	687.3	15.2%	147.1	17.8%	12/87
8	**Analog Devices**	15.1%	56.0	23.8%	370.4	10.8%	18.7	-20.2%	10/87
9	**Lotus Development**	14.8%	58.4	79.6%	395.6	39.9%	72.0	49.2%	12/87
10	**Tektronix**	14.3%	199.6	0.7%	1,395.9	2.8%	51.2	30.2%	5/87
11	**Computer Consoles**	14.0%	20.8	-13.3%	148.4	14.5%	9.6	NM	12/87
12	**Intel**	13.6%	259.8	13.8%	1,907.1	50.8%	175.5	NM	12/87
13	**GenRad**	13.6%	26.4	-26.6%	193.8	-5.2%	2.1	NM	12/87
14	**DSC Communications**	13.1%	40.9	-11.5%	312.4	2.8%	14.6	31.9%	12/87
15	**Computer Associates**	13.0%	40.1	58.1%	309.3	61.9%	36.5	96.9%	3/87
16	**Sun Microsystems**	12.9%	69.6	127.0%	537.5	155.8%	36.3	203.8%	6/87
17	**General DataComm**	12.6%	25.3	29.2%	200.6	12.7%	0.8	-80.1%	9/87
18	**Data General**	12.5%	159.4	11.4%	1,274.3	0.5%	-82.9	NM	9/87
19	**Avantek**	12.3%	26.3	3.5%	213.7	2.6%	11.6	-28.0%	12/87
20	**Amdahl**	11.9%	178.9	50.2%	1,505.2	55.8%	142.0	261.0%	12/87
21	**National Semiconductor**	11.7%	218.9	-1.6%	1,867.9	26.4%	-28.8	NM	5/87
22	**Digital Communications**	11.6%	21.1	35.3%	181.4	31.6%	27.0	31.2%	6/87
23	**Control Data**	11.6%	389.0	23.9%	3,366.5	0.6%	25.0	NM	12/87
24	**Prime Computer**	11.4%	109.7	19.3%	960.9	11.7%	64.8	38.0%	12/87
25	**Micom Systems**	11.3%	22.3	40.2%	196.7	3.8%	12.2	13.2%	3/87
26	**Coherent**	11.3%	18.0	21.4%	159.0	15.1%	-1.1	NM	9/87
27	**Cipher Data Products**	11.3%	20.1	33.3%	178.2	9.3%	4.3	-39.8%	6/87
28	**Hewlett-Packard**	11.1%	901.0	9.3%	8,090.0	13.9%	644.0	24.8%	10/87
29	**Apollo Computer**	11.0%	61.1	36.9%	553.7	41.4%	21.7	132.5%	12/87
30	**LSI Logic**	11.0%	28.9	34.1%	262.1	34.9%	10.7	178.8%	12/87
31	**Microsoft**	11.0%	38.1	85.5%	345.9	75.1%	71.9	83.1%	6/87
32	**Mentor Graphics**	10.9%	24.2	43.9%	221.8	27.8%	20.3	84.8%	12/87
33	**Fluke**	10.8%	22.2	-7.8%	206.3	-1.3%	2.0	-83.5%	9/87
34	**Digital Equipment**	10.8%	1,010.4	24.1%	9,389.4	23.7%	1,137.4	84.2%	6/87
35	**Intergraph**	10.5%	67.5	16.9%	641.1	5.8%	69.9	-0.7%	12/87
36	**Perkin-Elmer**	10.5%	140.2	33.5%	1,333.6	3.3%	-18.2	NM	7/87
37	**Tandem Computers**	10.5%	108.5	25.2%	1,035.5	34.9%	105.6	65.6%	9/87
38	**Ashton-Tate**	10.5%	28.0	43.5%	267.3	26.8%	43.1	43.1%	1/88
39	**Stratus Computer**	10.3%	18.9	34.0%	184.2	47.8%	19.4	43.5%	12/87
40	**Gould**	10.1%	94.3	-3.7%	933.4	2.7%	25.0	-27.7%	12/87
41	**IBM**	10.0%	5,434.0	36.7%	54,217.0	5.8%	5,258.0	9.8%	12/87
42	**Westmark International**	9.6%	28.0	17.9%	291.9	19.8%	-7.2	NM	12/87
43	**Quantum**	9.5%	11.5	1.8%	120.8	-0.4%	8.8	-60.4%	3/87
44	**ADC Telecommunications**	9.3%	15.5	19.2%	166.9	16.1%	15.3	27.5%	10/87
45	**Applied Magnetics**	9.2%	19.5	14.9%	211.9	65.4%	14.2	246.6%	9/87
46	**Dynatech**	9.0%	27.3	23.7%	304.7	18.7%	23.2	13.5%	3/87
47	**Altos Computer Systems**	9.0%	13.8	27.9%	153.9	14.7%	9.7	-52.3%	6/87
48	**AMP**	8.8%	204.0	20.0%	2,317.8	19.9%	249.7	51.9%	12/87
49	**TIE/communications**	8.6%	21.4	-6.2%	250.2	-16.1%	-11.1	NM	12/87
50	**3Com**	8.4%	9.3	86.7%	110.4	72.5%	11.1	66.8%	5/87

NM = Not meaningful. The company lost money in the base year

(Continued)

Top R&D spenders

1987 R&D rank	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Percentage change in expenditures from 1986	Fiscal 1987 revenue ($ millions)	Percentage change in revenue from 1986	Fiscal 1987 net income ($ millions)	Percentage change in net income from 1986	Fiscal year ended
51	**Medtronic**	8.4%	$42.1	9.3%	$502.0	24.6%	$73.8	9.5%	4/87
52	**ISC Systems**	8.4%	14.1	-5.2%	168.5	1.5%	6.5	-52.9%	6/87
53	**Varian Associates**	8.2%	80.7	-1.9%	982.8	10.3%	21.4	NM	9/87
54	**Paradyne**	8.2%	19.0	-2.4%	232.6	-10.9%	-2.6	NM	12/87
55	**Western Digital**	8.1%	37.4	51.6%	462.5	65.5%	42.8	99.2%	6/87
56	**Storage Technology**	8.0%	60.1	-3.3%	750.0	7.8%	19.0	12.8%	12/87
57	**Motorola**	7.8%	524.0	6.5%	6,707.0	13.9%	308.0	58.8%	12/87
58	**Texas Instruments**	7.7%	428.0	5.4%	5,594.5	12.5%	256.9	543.9%	12/87
59	**Micropolis**	7.5%	21.8	94.5%	288.3	35.2%	27.2	49.3%	12/87
60	**Wang Laboratories**	7.5%	212.4	4.7%	2,836.7	7.3%	70.7	38.9%	6/87
61	**Gerber Scientific**	7.4%	16.6	-7.2%	223.9	16.7%	21.1	15.8%	4/87
62	**Measurex**	7.3%	16.7	18.3%	227.4	18.0%	26.8	27.3%	11/87
63	**Apple Computer**	7.2%	191.6	49.9%	2,661.1	39.9%	217.5	451.7%	9/87
64	**Xerox**	7.0%	722.0	11.1%	10,320.0	10.3%	578.0	18.4%	12/87
65	**Diasonics**	6.9%	18.5	35.4%	267.6	23.2%	15.2	NM	12/87
66	**Aydin**	6.7%	10.0	32.4%	149.2	9.1%	8.8	26.6%	12/87
67	**Maxtor**	6.7%	11.8	98.3%	175.3	105.9%	22.4	109.5%	3/87
68	**Dataproducts**	6.6%	22.4	-27.9%	338.8	-4.3%	9.0	NM	3/87
69	**Watkins-Johnson**	6.4%	16.9	4.2%	264.3	3.5%	17.1	-0.7%	12/87
70	**NCR**	6.3%	356.6	11.2%	5,640.7	15.5%	419.3	24.6%	12/87
71	**Veeco Instruments**	6.2%	12.2	-1.4%	195.6	16.6%	9.2	2,328.2%	9/87
72	**Datapoint**	6.2%	19.4	-14.4%	312.1	-4.0%	-58.5	NM	7/87
73	**Unisys**	6.1%	597.0	35.4%	9,712.9	30.7%	578.0	NM	12/87
74	**Bolt Beranek and Newman**	6.1%	14.3	65.4%	233.8	31.3%	-8.0	NM	6/87
75	**Oracle Systems**	6.0%	7.9	12.9%	131.3	137.0%	15.6	165.0%	5/87
76	**Cherry Electrical Products**	6.0%	9.6	11.1%	160.6	24.2%	2.7	NM	2/87
77	**Harris**	5.7%	118.0	0.1%	2,079.0	-6.2%	84.5	41.8%	6/87
78	**Decision Industries**[1]	5.7%	10.9	6.4%	191.4	-1.9%	-20.4	NM	11/87
79	**M/A-COM**	5.6%	24.5	-28.0%	436.1	-24.5%	-29.3	NM	9/87
80	**Molex**	5.5%	21.2	23.6%	386.8	32.5%	43.4	35.5%	6/87
81	**MiniScribe**	5.5%	19.8	131.7%	362.5	96.0%	28.1	38.8%	12/87
82	**AST Research**	5.4%	11.1	32.1%	206.0	19.5%	13.0	-52.0%	6/87
83	**Wyse Technology**	5.3%	13.9	55.6%	260.0	56.2%	18.1	44.1%	3/87
84	**International Rectifier**	5.3%	8.1	-12.5%	151.8	4.6%	-17.2	NM	6/87
85	**Augat**	5.1%	16.1	-3.6%	313.2	20.4%	11.5	NM	12/87
86	**Genicom**	4.9%	14.9	143.3%	302.2	91.9%	12.6	45.9%	12/87
87	**Sprague Technologies**	4.8%	20.8	-6.7%	437.3	-2.6%	3.6	NM	12/87
88	**Litton Industries**	4.7%	209.7	-18.3%	4,419.7	-2.2%	138.1	94.3%	7/87
89	**Kollmorgen**	4.7%	14.2	-14.6%	301.0	-5.7%	0.3	NM	12/87
90	**Andrew**	4.7%	10.4	-21.7%	223.2	12.9%	3.8	-59.9%	9/87
91	**Esterline**	4.7%	12.1	6.1%	259.7	10.1%	-29.3	NM	10/87
92	**Loral**	4.6%	32.0	3.3%	690.0	4.0%	57.5	8.4%	3/87
93	**Recognition Equipment**	4.4%	11.6	0.3%	264.7	9.5%	11.2	6.4%	10/87
94	**Zenith Electronics**	4.4%	103.4	3.7%	2,362.7	24.9%	-19.1	NM	12/87
95	**Honeywell**	4.3%	289.8	17.5%	6,679.3	24.2%	253.7	1,866.7%	12/87
96	**Scientific-Atlanta**	4.1%	20.1	-27.1%	495.3	5.6%	24.8	NM	6/87
97	**MAI Basic Four**	4.0%	12.9	-16.0%	321.0	14.2%	22.8	34.9%	9/87
98	**Intelligent Systems**	4.0%	6.5	70.2%	163.2	30.0%	10.2	540.6%	12/87
99	**GM Hughes Electronics**	4.0%	416.0	1.9%	10,481.0	0.4%	521.1	17.1%	12/87
100	**Compaq Computer**	3.8%	47.1	77.1%	1,224.1	95.8%	136.3	217.7%	12/87

NM = Not meaningful. The company lost money in the base year

[1] Decision Industries went private April 29, 1988

Source: ELECTRONIC BUSINESS

Top R&D spenders by industry segment

Fiscal 1987 figures	Total R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D expenditures per employee
Minicomputers			
IBM	$5,434.0	10.0%	$13,957
Digital Equipment	$1,010.4	10.8%	$9,144
Hewlett-Packard	$901.0	11.1%	$10,988
Data General	$159.4	12.5%	$10,163
Prime Computer	$109.7	11.4%	$12,439
Tandem Computers	$108.5	10.5%	$15,481
Gould	$94.3	10.1%	$9,313
Sun Microsystems	$69.6	12.9%	$16,637
Apollo Computer	$61.1	11.0%	$15,285
Computer Consoles	$20.8	14.0%	$16,144
Stratus Computer	$18.9	10.3%	$15,449
MAI Basic Four	$12.9	4.0%	$3,960
Segment total	**$8,000.7**	—	—
Segment averages	—	**10.3%**	**$12,551**
Mainframes			
IBM	$5,434.0	10.0%	$13,957
Unisys	$597.0	6.1%	$6,454
Control Data	$389.0	11.6%	$11,275
NCR	$356.6	6.3%	$5,752
Amdahl	$178.9	11.9%	$23,545
Cray Research	$108.8	15.8%	$25,262
Segment total	**$7,064.4**	—	—
Segment averages	—	**9.4%**	**$11,968**
Office equipment			
IBM	$5,434.0	10.0%	$13,957
Xerox	$722.0	7.0%	$7,293
NCR	$356.6	6.3%	$5,752
Wang Laboratories	$212.4	7.5%	$7,009
Harris	$118.0	5.7%	$4,856
Pitney Bowes	$65.1	2.9%	$2,210
Datapoint	$19.4	6.2%	$7,046
Diebold	$14.3	3.3%	$2,938
Savin	$4.6	1.3%	$2,272
Segment total	**$6,946.4**	—	—
Segment averages	—	**8.9%**	**$10,785**
Microcomputers			
IBM	$5,434.0	10.0%	$13,957
Apple Computer	$191.6	7.2%	$34,206
Zenith Electronics	$103.4	4.4%	$2,954
Compaq Computer	$47.1	3.8%	$11,776
Atari	$18.0	3.7%	$4,412
Altos Computer	$13.8	9.0%	$17,646
AST Research	$11.1	5.4%	$8,186
Tandon	$10.3	3.6%	$2,938
Segment total	**$5,829.3**	—	—
Segment averages	—	**9.5%**	**$13,138**

	Total R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D expenditures per employee
Government			
Motorola	$524.0	7.8%	$5,363
Texas Instruments	$428.0	7.7%	$5,488
GM Hughes Electronics	$416.0	4.0%	$4,160
Honeywell	$289.8	4.3%	$3,674
Litton Industries	$209.7	4.7%	$3,869
Harris	$118.0	5.7%	$4,856
Gould	$94.3	10.1%	$9,313
Varian Associates	$80.7	8.2%	$6,784
Singer	$38.4	2.0%	$1,371
E-Systems	$33.7	2.7%	$2,173
Loral	$32.0	4.6%	$2,203
Watkins-Johnson	$16.9	6.4%	$5,414
Aydin	$10.0	6.7%	$5,023
Cubic	$5.2	1.4%	$1,164
Logicon	$1.6	0.8%	$643
Segment total	**$2,298.4**	—	—
Segment averages	—	**5.4%**	**$4,376**
Semiconductors			
Motorola	$524.0	7.8%	$5,363
Texas Instruments	$428.0	7.7%	$5,488
Intel	$259.8	13.6%	$13,531
Advanced Micro Devices	$247.8	24.9%	$13,755
National Semiconductor	$218.9	11.7%	$7,497
Harris	$118.0	5.7%	$4,856
Gould	$94.3	10.1%	$9,313
Analog Devices	$56.0	15.1%	$10,777
Western Digital	$37.4	8.1%	$11,204
VLSI Technology	$30.5	17.8%	$22,698
LSI Logic	$28.9	11.0%	$12,465
International Rectifier	$8.1	5.3%	$3,429
Segment total	**$2,051.7**	—	—
Segment averages	—	**9.5%**	**$7,049**
Capital equipment			
Hewlett-Packard	$901.0	11.1%	$10,988
Tektronix	$199.6	14.3%	$11,676
Perkin-Elmer	$140.2	10.5%	$9,929
Varian Associates	$80.7	8.2%	$6,784
Teradyne	$61.5	16.3%	$13,089
Applied Materials	$31.2	17.9%	$22,193
GenRad	$26.4	13.6%	$12,484
LTX	$23.2	19.2%	$19,919
John Fluke	$22.2	10.8%	$9,258
Gerber Scientific	$16.6	7.4%	$9,229
Esterline	$12.1	4.7%	$3,834
Sun Electric	$5.0	2.4%	$2,035
Segment total	**$1,519.7**	—	—
Segment averages	—	**11.2%**	**$10,532**

(Continued)

Top R&D spenders by industry segment

Fiscal 1987 figures	Total R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D expenditures per employee
Computer-based systems			
Hewlett-Packard	$901.0	11.1%	$10,988
Honeywell	$289.8	4.3%	$3,674
Intergraph	$67.5	10.5%	$10,710
Coherent	$18.0	11.3%	$11,106
Measurex	$16.7	7.3%	$6,578
Gerber Scientific	$16.6	7.4%	$9,229
ISC Systems	$14.1	8.4%	$7,898
Recognition Equipment	$11.6	4.4%	$3,990
Sun Electric	$5.0	2.4%	$2,035
Segment total	**$1,340.3**	—	—
Segment averages	—	**8.0%**	**$7,434**
Communications			
Motorola	$524.0	7.8%	$5,363
DSC Communications	$40.9	13.1%	$16,076
Dynatech	$27.3	9.0%	$8,818
Avantek	$26.3	12.3%	$8,651
General DataComm	$25.3	12.6%	$9,574
General Instrument	$24.7	3.1%	$1,517
M/A-COM	$24.5	5.6%	$3,624
Micom Systems	$22.3	11.3%	$10,924
TIE/communications	$21.4	8.6%	$14,298
Digital Communications	$21.1	11.6%	$17,775
Scientific-Atlanta	$20.1	4.1%	$5,999
Paradyne	$19.0	8.2%	$6,095
ADC Telecommunications	$15.5	9.3%	$8,615
Bolt Beranek and Newman	$14.3	6.1%	$5,352
Andrew	$10.4	4.7%	$4,528
Aydin	$10.0	6.7%	$5,023
3Com	$9.3	8.4%	$16,837
Dynascan	$1.6	0.8%	$4,145
Segment total	**$858.0**	—	—
Segment averages	—	**7.5%**	**$5,609**
Peripherals			
Control Data	$389.0	11.6%	$11,275
Storage Technology	$60.1	8.0%	$6,776
Seagate Technology	$33.6	3.5%	$2,097
Dataproducts	$22.4	6.6%	$5,731
Micropolis	$21.8	7.5%	$9,124
Cipher Data Products	$20.1	11.3%	$10,683
MiniScribe	$19.8	5.5%	$3,988
Applied Magnetics	$19.5	9.2%	$2,807
Genicom	$14.9	4.9%	$4,163
Wyse Technology	$13.9	5.3%	$6,863
Maxtor	$11.8	6.7%	$6,109

Continued next column

	Total R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D expenditures per employee
Peripherals (continued)			
Xidex	$11.6	2.0%	$1,679
Quantum	$11.5	9.5%	$16,522
Decision Industries	$10.9	5.7%	$7,027
Tandon	$10.3	3.6%	$2,938
Intelligent Systems	$6.5	4.0%	$13,235
Segment total	**$688.6**	—	—
Segment averages	—	**7.9%**	**$6,786**
Components			
AMP	$204.0	8.8%	$9,273
Molex	$21.2	5.5%	$4,264
Sprague Technologies	$20.8	4.8%	$2,414
Augat	$16.1	5.1%	$4,237
Cherry Electrical	$9.6	6.0%	$3,333
AVX	$8.4	3.1%	$1,120
CTS	$5.3	2.0%	$798
BRIntec	$4.5	1.5%	$1,152
Oak Industries	$4.0	2.2%	$1,046
Segment total	**$293.9**	—	—
Segment averages	—	**6.4%**	**$4,581**
Software			
Lotus Development	$58.4	14.8%	$27,819
Cullinet Software	$49.9	28.5%	$20,723
Computer Associates	$40.1	13.0%	$14,853
Microsoft	$38.1	11.0%	$20,967
Ashton-Tate	$28.0	10.5%	$22,388
Mentor Graphics	$24.2	10.9%	$20,149
Oracle Systems	$7.9	6.0%	$7,026
Ultimate	$4.5	2.6%	$10,000
Segment total	**$251.1**	—	—
Segment averages	—	**12.4%**	**$19,244**
Medical			
Medtronic	$42.1	8.4%	$8,504
Westmark International	$28.0	9.6%	$9,267
Diasonics	$18.5	6.9%	$12,243
Segment total	**$88.6**	—	—
Segment averages	—	**8.3%**	**$9,342**

Segment R&D as a percentage of revenue averages are weighted

Source: ELECTRONIC BUSINESS

Power pay: How the big guys made even more money

The 100 highest-paid electronics executives had to put up with a 23% raise last year. Their average take-home? Just $780,000

BY TONY GREENE

Most of us fret about how we're going to make ends meet on our inflation-pacing salary increments. But not the top executives in the U.S. electronics industry. The 100 highest-paid are plagued instead by the nightmare of how to spend their 23% raise.

According to a new survey by ELECTRONIC BUSINESS, the average paycheck for the top-paid 100 electronics executives rose $149,094 in 1987, or 23.5% over the past year, making for an average *weekly* compensation of $15,100.

And ELECTRONIC BUSINESS' "million-dollar club" boosted its membership dramatically as the ranks of those bringing home seven-figure compensation rose from six to 17. Disk-drive maker Seagate Technology Inc. claimed the honor of having the most new members initiated into the club, bringing three new names to the list.

The big winners were computer company executives, with over 50% of this year's highest-paid 100 coming from computer, peripherals or software companies. Also, with the exception of Xerox Corp. and Advanced Micro Devices Inc., all the members of the million-dollar club came from this same group.

One of the major reasons for the boost to top executive compensation is the increased profitability of the electronics industry in 1987. The recent ELECTRONIC BUSINESS 200 survey found that sales for the top 200 U.S. electronics companies were up 7.4%, while profitability climbed 53.6% [ELECTRONIC BUSINESS July 15, 1988 p26]. This translates into dollar signs for executives whose salaries and bonuses are normally tied to the performance of the company.

While cash is still king in the world of executive compensation, there are other factors that top staffers are beginning to look for. Research by ELECTRONIC BUSINESS reveals several distinct trends:

- Contracts, which have not been prevalent until recently, are becoming more popular. This is believed to be mainly in response to executives' need for a feeling of security in today's volatile mergers-and-acquisitions world.
- As the industry matures, companies are looking for older, more seasoned executives to head companies. But "mature" is a relative term; and senior executives in the electronics industry still tend to be younger than execs in other industries.

The bottom line for the electronics industry's highest-paid execs: Cash is still king

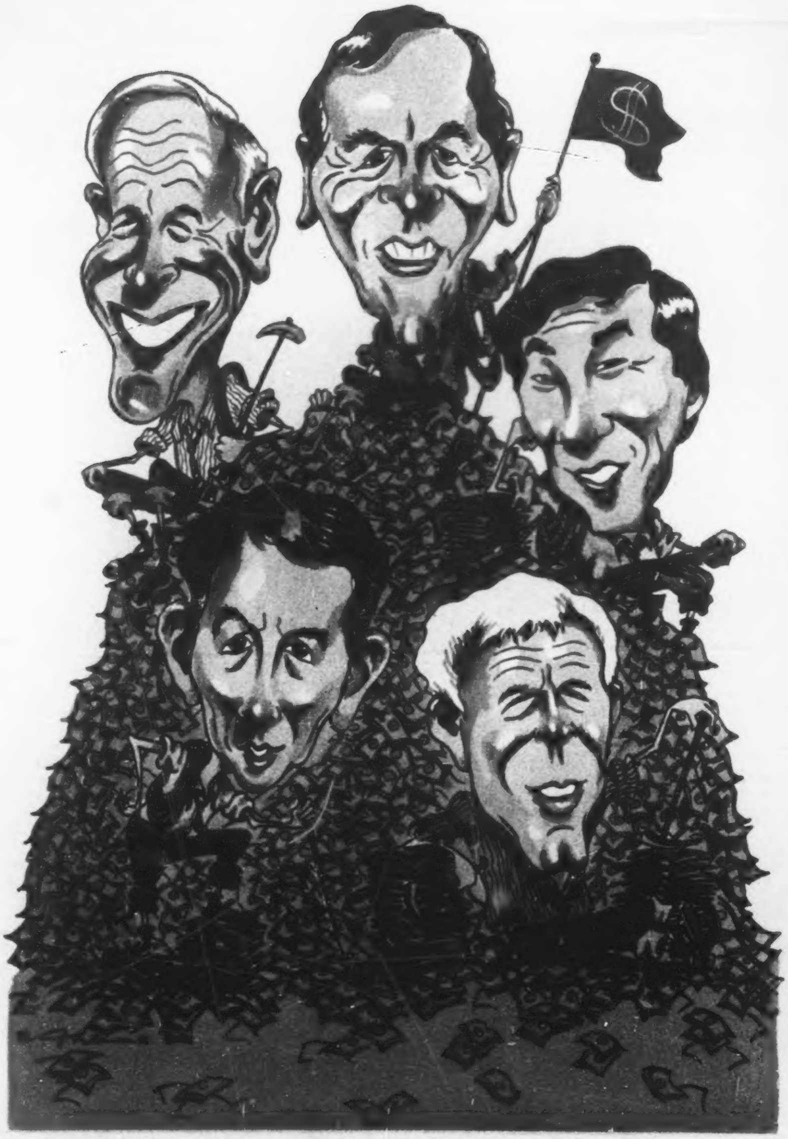
- Perquisites such as company houses and cars, while still nice, are not the incentive they used to be under the new tax laws. Executives and their recruiters are holding their breath to see what the coming year will bring in the area of taxes.
- Executive recruiters see a shortage of qualified upper level executives in the future of the electronics industry — a shortage that will make compensation a critical factor as companies strive to get and keep top level people.

Seagate is one company that should not have to worry about keeping its execs. The disk-drive maker boasts three chiefs in the ELECTRONIC BUSINESS power-pay club — David T. Mitchell, president and COO; Douglas K. Mahon, senior vice president and chief technical officer; and Alan F. Shugart, chairman of the board and CEO. And it places two other executives in the top 100, putting all five of their top-paid executives on the rolls.

Seagate's top trio experienced an average increase of 209.2% — compensation that came as a direct response to the company's performance in 1986 and 1987. Seagate declined to comment on whether salaries this year would show a corresponding decrease as the company reported a fall in net income of 56% in the fourth quarter of fiscal 1988, ended June 30.

In addition to Seagate, Apple Computer Inc., Compaq Computer Corp. and Unisys Corp. all put five executives in the top 100. John Sculley, Apple's president and CEO, leads this year's list with a modest increase of 26.1% to $2,140,000. The No. 2 on ELECTRONIC BUSINESS' top-pay list, W. Michael Blumenthal, chairman and CEO of Unisys Corp., is the only person in the top five to show a decrease: 28.8% down from 1986 to give him cash compensation of $1,549,440.

Honeywell Inc.'s top paid executives — Edson W. Spenser, chairman and CEO; and James J. Renier, president and COO — provide a good example of how executive compensation can be tied to profitability. Both men experienced reductions in their cash compensation in 1986 [ELECTRONIC BUSINESS Oct. 15, 1987 p52] when Honywell reported a loss of $389 million. In fact, in 1987, when the company showed net income of $254 million, Spenser and Renier had an average increase of 88.5%. A spokesperson for Honeywell says that executive compensation is tied to three factors: the company's earn-



The men with the megabucks: Apple Computer chairman John Sculley, $2,140,000; Unisys chairman Michael Blumenthal, $1,549,440; Computer Associates CEO Charles Wang, $1,431,000; Compaq Computer president Joseph "Rod" Canion, $1,375,000; and Seagate Technology president David "Tom" Mitchell, $1,354,975

Dorothy Ahle

ings, return on investment and return on equity.

Executive salaries have risen strongly throughout the electronics industry. A recent survey by the American Electronics Association shows that last year, executive salaries posted their largest average increase — 7.5% — since 1984. This is up more than 2% from the previous year. This is still not as high, though, as the average increase for top executives in all industries. Jill Kanin-Lovers, an associate at Towers, Perrin, Forster and Crosby, a New York City-based consulting firm that specializes in executive compensation, says that according to their survey, senior benchmark salaries rose an average of 12% in 1988.

Sign here, please

Although salaries are going up and business is good, many executives are edgy about their security and are asking for contracts. Alan Glou, president of Needham, Massachusetts-based Glou International Inc., an executive search firm that specializes in the electronics industry, says, "They're looking for security with companies that have the ability to be acquired." What most of the contracts amount to is a guarantee of severance pay — a buy-out clause — if the company is acquired. Chris Blake, president of San Jose executive search firm Robert S. Blake Associates Inc., says, "There is no security in the electronics industry —only opportunity."

Another factor that is going to be figuring into executive compensation is the law of supply and demand. "There is a shortage of seasoned, qualified people at the upper executive level," says James W. Furlong, president of Van Nuys, California-based executive search firm Furlong-Gates. As the industry matures, there is a greater need for experienced top level management that will give executives leverage to demand greater cash compensation in the future.

One of the problems is the general feeling — Sculley's crossover from PepsiCo Inc. to Apple notwithstanding — that executives from other industries cannot run electronics concerns. Gene Spence, a partner at the executive search firm Heidrick and Struggles Inc., which placed Sculley at Apple, says, "Sculley is the exception, not the norm."

The bottom line is that cash is still king. Perquisites such as company houses and cars are not as popular as they once were because thay are currently taxed like cash, so senior staffers feel they may as well settle for cash in the first place. But, while cash may be king, stock options are not dead. They are still a major part of any upper-level compensation package. The increase in cash is in addition to, not instead of, stock options. This is even true of executives going to start-ups and venture capital-backed firms. "Gone are the days when executives will take a hit to go to a venture-funded company," says Spence. ☐

Top paid executives

Rank	Executive/age	1987 salary	Percentage change from previous year	Company	Position
1	**John Sculley/48**	$2,140,000	26.1%	Apple Computer	Chairman, president, CEO
2	**W. Michael Blumenthal/62**	1,549,440	-28.8%	Unisys	Chairman, CEO
3	**Charles B. Wang/43**	1,431,000	NA	Computer Associates	CEO, chairman
4	**Joseph R. Canion/42**	1,375,000	150.0%	Compaq Computer	President, CEO, director
5	**David T. Mitchell/45**	1,354,975	193.2%	Seagate Technology	President, COO
6	**Douglas K. Mahon**	1,274,120	210.4%	Seagate Technology	Senior VP, chief technical officer
7	**Alan F. Shugart/56**	1,263,951	223.9%	Seagate Technology	Chairman, CEO
8	**Paul G. Stern/48**[1]	1,195,920	43.4%	Unisys	President
9	**John A. Young/55**	1,193,300	29.8%	Hewlett-Packard	President, CEO, chairman
10	**Anthony W. Wang/45**	1,188,000	NA	Computer Associates	President, COO, director
11	**David T. Kearns/57**	1,165,465	33.2%	Xerox	Chairman, CEO
12	**W.J. Sanders III/51**	1,057,080	121.6%	Advanced Micro Devices	Chairman, CEO
13	**Joseph J. Kroger**	1,029,337	NA	Unisys	Vice chairman
14	**Fred W. O'Green/66**	1,022,510	NA	Litton Industries	Chairman, director
15	**Edson W. Spenser/61**	1,014,185	80.5%	Honeywell	Chairman, director
16	**Charles E. Exley Jr./58**	1,001,200	6.7%	NCR	Chairman, CEO
17	**Paul C. Ely Jr./56**	1,000,000	-15.9%	Convergent	Chairman
18	**Jim P. Manzi/36**	940,872	18.4%	Lotus	President, chairman, director
19	**John V. Roach/48**	916,240	50.5%	Tandy	Chairman, CEO, president
20	**Kenneth H. Olsen/61**	905,706	20.0%	Digital Equipment	President, CEO
21	**Thomas P. Howes**[2]	901,000	NA	Esterline	President
22	**John C. Lewis/52**	898,013	8.1%	Amdahl	Chairman, CEO
23	**Robert M. Price/57**	885,858	7.0%	Control Data	Chairman, president, CEO
24	**Melvin Howard/53**	875,952	24.5%	Xerox	Vice chairman, subsidiary officer
25	**Edward M. Esber, Jr./35**	874,086	-7.3%	Ashton Tate	Chairman, CEO
26	**James J. Renier/58**	861,256	96.5%	Honeywell	President, COO, CEO, director
27	**John F. Akers/53**	840,896	18.1%	IBM	Chairman
28	**David R. Tacke/65**	837,319	22.2%	E-Systems	Chairman, CEO
29	**Delbert W. Yocam**	832,000	69.2%	Apple Computer	Executive VP, COO
30	**John F. Cunningham/45**	831,664	NA	Computer Consoles	Chairman, president, CEO
31	**Jean-Louis Gassee**	831,000	148.5%	Apple Computer	VP product development
32	**Eckhard Pfeiffer/45**	827,965	176.0%	Compaq Computer	Senior VP international
33	**Stephen L. Lane/51**	827,500	NA	Emerson Radio	President
34	**William W. Lane/53**	827,500	NA	Emerson Radio	Chairman
35	**John T. Hartley/57**	819,578	30.0%	Harris	President, CEO
36	**Anthony R. Hamiliton/63**	814,668	14.3%	Avnet	Chairman, CEO
37	**Leon Machiz/63**	814,668	14.3%	Avnet	Vice chairman, COO, president
38	**William F. Glavin/56**	800,014	37.6%	Xerox	Vice chairman
39	**Frank G. Hickey/60**	797,767	79.8%	General Instrument	Chairman, CEO
40	**James A. Unruh/46**[1]	795,961	73.3%	Unisys	Executive VP
41	**George B. Harvey/56**	794,093	-28.0%	Pitney Bowes	Chairman, president, CEO
42	**Orion L. Hoch/58**	782,621	NA	Litton Industries	President, CEO, director
43	**Donald L. Waite**	762,303	191.1%	Seagate Technology	Senior VP, CFO
44	**William F. Schmied/59**	756,933	28.3%	Singer	President, COO
45	**Dean O. Morton/55**	750,121	29.6%	Hewlett-Packard	Executive VP, COO, director
46	**William J. Weisz/60**	746,170	27.1%	Motorola	Vice chairman
47	**Joe M. Henson/54**	737,857	7.9%	Prime Computer	President, CEO, director
48	**Lawrence J. Ellison/43**	711,875	NA	Oracle	President
49	**Paul A. Allaire/49**	709,119	49.3%	Xerox	President
50	**Michael H. Spindler**	709,000	47.6%	Apple Computer	Senior VP, int'l sales & marketing

[1] resigned Dec. 31, 1987
[2] resigned
NA = Not available

(Continued)

Top paid executives

Rank	Executive/age	1987 salary	Percentage change from previous year	Company	Position
51	**Norbert R. Berg/56**	$707,940	5.2%	Control Data	Deputy chairman
52	**Andrew S. Grove/51**	697,011	92.5%	Intel	President, COO
53	**Bertil D. Nordin/53**[3]	686,077	85.5%	Digital Communications	President, chairman, CEO
54	**Sidney Topol/62**	685,995	76.6%	Scientific-Atlanta	Chairman
55	**C. Peter McColough/65**	685,310	23.8%	Xerox	Chairman executive committee
56	**Jerry R. Junkins/50**	685,000	37.0%	Texas Instruments	President, CEO
57	**Gordon E. Moore/59**	684,419	85.7%	Intel	Chairman
58	**Eugene R. White/56**	682,915	8.7%	Amdahl	Vice president
59	**John F. Mitchell/59**	679,575	33.2%	Motorola	President, director
60	**Marshall D. Butler/61**	679,000	175.7%	AVX	Chairman
61	**James L. Donald/55**	678,574	75.2%	DSC Communications	President, CEO
62	**Harold Falik/37**	678,100	NA	Emerson Radio	Senior VP
63	**Stanley A. Wainer/61**	670,000	21.8%	Wyle Laboratories	Chairman, CEO
64	**K.V. Cassani/59**	667,231	NA	IBM	Vice chairman
65	**Mark Shepherd Jr./65**	660,020	43.5%	Texas Instruments	Chairman
66	**Bernard S. Appel**	659,673	44.1%	Tandy	President Radio Shack div.
67	**Jack D. Kuehler/55**	656,126	23.5%	IBM	Vice chairman
68	**Thomas A. Vanderslice/56**	650,190	NA	Apollo	Chairman, CEO
69	**John F. Gribi/45**	650,000	140.7%	Compaq Computer	Senior VP finance, CFO
70	**Luther Nussbaum/45**	641,922	82.1%	Ashton-Tate	President, COO
71	**Albert A. Eisenstat/57**	640,000	60.8%	Apple Computer	Sr. VP, general counsel, secretary
72	**Frank A. Brand/63**	627,500	141.3%	M/A-COM	Senior VP, chief technical officer
73	**William G. Moore Jr./48**	624,077	-29.6%	Recognition Equipment	Chairman, president, CEO
74	**Sing C. Tien**	615,470	NA	Seagate Technology	Senior VP, Far East operations
75	**E. Joseph Zemke/47**	604,987	19.4%	Amdahl	President, COO, director
76	**Robert W. Galvin/65**	600,000	10.5%	Motorola	Chairman
77	**Michael S. Swavely**	600,000	NA	Compaq Computer	VP, sales & marketing
78	**Thomas F. Burke/58**	600,000	160.9%	M/A-COM	President, CEO, COO
79	**Frederick A. Krehbiel/45**	575,546	95.1%	Molex	Executive VP, president Molex Int'l
80	**Winston R. Wallin/62**	569,498	0.6%	Medtronic	Chairman, president, CEO
81	**John A. Rollwagen/47**	564,877	-9.2%	Cray Research	Chairman, CEO
82	**James F. McDonald/48**	559,225	-14.5%	Gould	Chairman, president, CEO
83	**A.J. Krowe/55**	557,408	NA	IBM	Executive VP
84	**James M. Eckhart/56**	555,000	96.6%	Compaq Computer	Senior VP corporate operations
85	**David A. Bossen/61**	543,000	6.7%	Measurex	President, CEO, director
86	**Roger W. Johnson/53**	542,375	23.2%	Western Digital	Chairman, president, CEO
87	**Walter F. Raab/63**	541,000	9.7%	AMP	Chairman, CEO, director
88	**George M. Scalise/54**	538,418	NA	Maxtor	President, CEO
89	**Donald J. Atwood/64**	538,000	NA	General Motors	President GM Hughes Electronics
90	**Donald Dvorkin/44**	537,500	NA	Emerson Radio	Executive VP
91	**Joseph T. Casey/56**	535,056	NA	Litton Industries	Executive VP, CFO, director
92	**William E. Terry/54**	533,013	24.4%	Hewlett-Packard	Executive VP, director
93	**Hollis L. Caswell**	527,140	NA	Unisys	Senior VP
94	**Charles M. Clough/59**	520,000	4.0%	Wyle Laboratories	President, COO
95	**Leslie L. Vadasz/51**	519,774	84.0%	Intel	Senior VP
96	**William E. Johnson/46**	514,482	NA	Scientific-Atlanta	Vice chairman, CEO
97	**James G. Treybig/47**	513,405	47.7%	Tandem Computers	President, CEO, director
98	**John J. Shields/57**	512,233	26.5%	Digital Equipment	Senior VP
99	**John F. Smith/52**	511,114	26.2%	Digital Equipment	Senior VP
100	**Joseph F. Caligiuri**	508,698	NA	Litton Industries	Executive VP

[3] became chairman April 1987, resigned as president
NA = Not available

Source: ELECTRONIC BUSINESS

Capital spending: The boom will end, but '89 is no bust

Capital equipment vendors should enjoy 1988 while they can — 1989 forecasts call for a slower spending pace. Big-ticket buys could continue

BY LINDA STALLMANN AND DAVID CARD

Forecasters expect electronics companies to slow their capital spending pace in 1989.

That's the bad news. The good news is that the comparison is relative to 1988, which will close out as a capital equipment boomlet.

The top 100 U.S. electronics companies spent $14.3 billion on capital equipment last year, up 3.9% from what those same companies spent in 1986. (Only those companies from the ELECTRONIC BUSINESS 200 [July 15, 1988] that derive at least 70% of their total revenue from electronics are compared.) This year's growth will be even greater, as projections for some specific industry sectors suggest.

According to a survey by Lexington, Massachusetts-based Data Resources Inc., companies making electrical and electronic components will increase their spending this year by 42.7% compared with last year. The research firm shows spending by communication equipment companies up 13.6% in 1988, and office equipment makers up 25.8%.

But watch out for 1989, cautions DRI economist Nigel Gault. Preliminary budgeting plans at component companies call for only a 19% increase in 1989. And communication and office equipment suppliers will cut spending by 10% and 11.3%, respectively.

Gault points out that there is a "built-in tendency to underestimate spending plans," so 1989 probably will not be as bad as the early budgets indicate. Capital equipment vendors, Gault says, "shouldn't be planning on an increase like 1988, but at the moment, it looks like 1989 will be a reasonably good year."

Caution on 1989 is the watchword with other forecasters too. If she were an equipment supplier, Elizabeth Baatz of Cahners Economics says, "I wouldn't be terrified, but I'd be keeping my eye open" looking toward 1989. Cahners Economics is pretty negative on the general economy, expecting a 1989 gross national product growth of only 1.1%.

Rebound in 1990

Cahners Economics forecasts manufacturing spending across all industries to increase 10.7% in 1988, but expects it to shrink 0.9% the next year. 1990 will rebound, with spending growing 5.2%. "Things people can order in smaller quantities will drop off sooner," Baatz says of 1989, indicating that spending on expensive items — automatic test equipment, for example — may hold up longer, but drop off in early 1990.

Last year, semiconductor companies spent the most on capital equipment as a percentage of sales. Custom chip makers LSI Logic Corp. and VLSI Technology Inc. spent 67% and 29%, respectively.

However, the spree is over for now, says LSI Logic chief financial officer D. Scott Mercer. This year, he has cut spending by 66%, down to around $60 million, anticipating pick-up to the $80 million to $100 million range in 1989.

So is Chrysler Corp.'s electronics assembly subsidiary; it bought some testers this year and is looking to add more. Computer-aided design and manufacturing equipment and surface-mount assembly equipment are also on plant manager Roger Rickey's shopping list. He expects to spend $40 million to $50 million over the next three or four years.

But are America's computer companies spending enough? Not according to Arthur D. Little Inc. analyst Jerry Wasserman. He evaluates a company's capital spending by comparing it with its net cash flow — the ratio of equipment spending to profits plus depreciation after dividends. Wasserman likes to see a 100% to 130% ratio, but in 1987, most of the big computer companies, for example, were nowhere near that ratio.

Wasserman speculates that they were watching the bottom line too closely. To compete against Japanese companies with their access to cheaper capital, managers in the United States must look further ahead, Wasserman insists. "We have got to have CEOs willing to stand up in front of the financial community and in front of their boards of directors," he says. "Unless they make the long-term investments, their companies are going to be buried." ☐

Top capital spenders

1987 rank	Company	Total capital expenditures ($ millions)	Percentage change in expenditures from 1986	Capital expenditures as a percentage of revenue	Capital expenditures to net cash flow after dividends	Total company revenue ($ millions)	Fiscal year ended
1	**IBM**	$4,304.0	-6.8%	7.9%	70.2%	$54,217.0	12/87
2	**Xerox**	937.0	-9.2%	9.1%	97.3%	10,320.0	12/87
3	**DEC**	748.4	32.6%	8.0%	47.6%	9,389.4	6/87
4	**Unisys**	720.9	30.3%	7.4%	75.4%	9,712.9	12/87
5	**Motorola**	658.0	11.0%	9.8%	91.5%	6,707.0	12/87
6	**Hewlett-Packard**	507.0	1.6%	6.3%	54.8%	8,090.0	10/87
7	**GM Hughes Electronics**	469.4	-33.0%	4.5%	56.1%	10,481.0	12/87
8	**Texas Instruments**	462.8	3.8%	8.3%	82.0%	5,594.5	12/87
9	**NCR**	389.2	7.9%	6.9%	62.4%	5,640.7	12/87
10	**Honeywell**	304.2	8.1%	4.6%	53.0%	6,679.3	12/87
11	**Intel**	301.5	94.8%	15.8%	86.9%	1,907.1	12/87
12	**Pitney Bowes**	251.8	20.6%	11.2%	88.9%	2,250.5	12/87
13	**Litton Industries**	242.8	-17.4%	5.5%	84.7%	4,419.7	7/87
14	**Storage Technology**	179.2	454.8%	23.9%	183.5%	750.0	12/87
15	**Control Data**	178.3	13.8%	5.3%	73.8%	3,366.5	12/87
16	**LSI Logic**	174.5	147.5%	66.6%	339.5%	262.1	12/87
17	**AMP**	171.8	13.3%	7.4%	57.6%	2,317.8	12/87
18	**Amdahl**	157.8	37.8%	10.5%	66.2%	1,505.2	12/87
19	**Data General**	142.9	10.1%	11.2%	576.1%	1,274.3	9/87
20	**Tandem Computers**	142.4	119.0%	13.7%	90.3%	1,035.5	9/87
21	**Advanced Micro Devices**	137.9	0.8%	13.8%	141.8%	997.1	12/87
22	**Wang Laboratories**	128.0	-45.2%	4.5%	42.8%	2,836.7	6/87
23	**Compaq Computer**	113.3	124.4%	9.3%	71.4%	1,224.1	12/87
24	**Prime Computer**	100.5	10.9%	10.5%	69.0%	960.9	12/87
25	**National Semiconductor**	94.7	-19.0%	5.1%	79.2%	1,867.9	5/87
26	**Tandy**	93.1	69.2%	2.7%	34.3%	3,452.2	6/87
27	**Apple Computer**	86.1	29.3%	3.2%	31.6%	2,661.1	9/87
28	**Harris**	83.6	-28.3%	4.0%	39.7%	2,079.0	6/87
29	**Singer**	78.7	-13.1%	4.1%	109.5%	1,902.7	12/87
30	**Seagate Technology**	78.4	102.7%	8.2%	46.8%	958.1	6/87
31	**Sun Microsystems**	76.1	110.2%	14.2%	124.0%	537.5	6/87
32	**Tektronix**	66.8	-2.4%	4.8%	49.5%	1,395.9	5/87
33	**Perkin-Elmer**	66.5	-2.9%	5.0%	492.2%	1,333.6	7/87
34	**General Instrument**	63.2	-13.8%	8.0%	103.7%	787.9	2/87
35	**Microsoft**	58.0	311.2%	16.8%	73.0%	345.9	6/87
36	**Zenith Electronics**	55.4	-9.2%	2.3%	247.3%	2,362.7	12/87
37	**Apollo Computer**	53.7	29.3%	9.7%	84.3%	553.7	12/87
38	**E-Systems**	51.1	7.0%	4.2%	68.3%	1,227.2	12/87
39	**MiniScribe**	50.5	139.5%	13.9%	128.2%	362.5	12/87
40	**VLSI Technology**	50.1	79.3%	29.1%	152.1%	172.0	12/87
41	**Molex**	49.5	23.3%	12.8%	65.2%	386.8	6/87
42	**Gould**	49.0	-14.3%	5.2%	51.2%	933.4	12/87
43	**Avnet**	47.3	109.7%	3.1%	146.5%	1,547.1	6/87
44	**Varian Associates**	46.2	-7.7%	4.7%	87.3%	982.8	9/87
45	**Intergraph**	43.7	-44.3%	6.8%	44.8%	641.1	12/87
46	**Analog Devices**	43.0	17.2%	11.6%	82.1%	370.4	10/87
47	**Teradyne**	41.0	34.9%	10.8%	374.1%	377.7	12/87
48	**Western Digital**	40.6	149.8%	8.8%	66.7%	462.5	6/87
49	**Cray Research**	40.2	-66.3%	5.8%	18.3%	687.3	12/87
50	**Loral**	34.2	-26.0%	5.0%	45.9%	690.0	3/87

Source: ELECTRONIC BUSINESS

(Continued)

Top capital spenders

1987 rank	Company	Total capital expenditures ($ millions)	Percentage change in expenditures from 1986	Capital expenditures as a percentage of revenue	Capital expenditures to net cash flow after dividends	Total company revenue ($ millions)	Fiscal year ended
51	**AVX**	$31.8	187.4%	11.7%	91.9%	$271.9	12/87
52	**SCI Systems**	29.6	172.1%	5.4%	104.8%	552.9	6/87
53	**Augat**	29.4	22.5%	9.4%	136.0%	313.2	12/87
54	**Altos Computer**	28.9	1,039.8%	18.8%	199.8%	153.9	6/87
55	**Medtronic**	28.4	469.6%	5.7%	32.3%	502.0	4/87
56	**M/A-COM**	26.7	-72.7%	6.1%	-295.1%	436.1	9/87
57	**Lotus Development**	26.6	71.1%	6.7%	30.3%	395.6	12/87
58	**Applied Magnetics**	25.7	148.4%	12.1%	98.8%	211.9	9/87
59	**Datapoint**	25.6	-2.8%	8.2%	-74.1%	312.1	7/87
60	**Avantek**	24.4	21.5%	11.4%	97.7%	213.7	12/87
61	**Sprague Technologies**	24.3	-38.2%	5.6%	76.2%	437.3	12/87
62	**DSC Communications**	23.2	21.5%	7.4%	53.5%	312.4	12/87
63	**Micropolis**	22.3	38.6%	7.7%	62.0%	288.3	12/87
64	**Bolt Beranek and Newman**	22.2	27.8%	9.5%	489.1%	233.8	6/87
65	**Recognition Equipment**	21.7	79.9%	8.2%	96.6%	264.7	10/87
66	**Compugraphic**	19.7	34.8%	5.4%	NA	367.1	12/87
67	**Digital Communications**	19.0	127.9%	10.5%	57.4%	181.4	6/87
68	**Maxtor**	17.4	125.8%	9.9%	66.1%	175.3	3/87
69	**Cubic**	17.1	98.6%	4.7%	118.8%	361.8	9/87
70	**Oracle Systems**	16.9	47.3%	12.9%	80.6%	131.3	5/87
71	**Cherry Electrical**	15.4	68.6%	9.6%	114.5%	160.6	2/87
72	**General DataComm**	15.3	-4.4%	7.6%	134.9%	200.6	9/87
73	**Mentor Graphics**	14.7	44.1%	6.6%	43.2%	221.8	12/87
74	**Stratus Computer**	13.8	-11.6%	7.5%	49.6%	184.2	12/87
75	**LTX**	13.6	156.0%	11.3%	283.6%	120.6	7/87
76	**Kollmorgen**	13.5	8.3%	4.5%	124.2%	301.0	12/87
77	**CTS**	13.4	-50.7%	5.1%	63.7%	261.1	12/87
78	**MAI Basic Four**	13.2	73.4%	4.1%	47.6%	321.0	9/87
79	**Convergent**	12.9	-62.8%	3.3%	NA	384.8	12/87
80	**Dynatech**	12.6	1.5%	4.1%	37.3%	304.7	3/87
81	**Watkins-Johnson**	12.3	-9.6%	4.7%	47.0%	264.3	12/87
82	**Paradyne**	12.2	-40.8%	5.2%	52.0%	232.6	12/87
83	**Tandon**	12.1	49.3%	4.2%	52.2%	289.1	12/87
84	**Andrew**	11.7	13.9%	5.2%	70.3%	223.2	9/87
85	**GenRad**	11.6	0.5%	6.0%	66.0%	193.8	12/87
86	**Applied Materials**	11.5	0.4%	6.6%	119.6%	174.4	10/87
87	**ADC Telecommunications**	11.1	10.3%	6.7%	47.5%	166.9	10/87
88	**Cullinet Software**	11.0	-59.2%	6.3%	-124.9%	174.9	4/87
89	**Dataproducts**	11.0	20.8%	3.2%	60.2%	338.8	3/87
90	**Gerber Scientific**	10.6	49.6%	4.7%	41.4%	223.9	4/87
91	**Westmark International**	10.5	-37.4%	3.6%	366.7%	291.9	12/87
92	**Computer Associates**	10.4	71.2%	3.4%	16.4%	309.3	3/87
93	**BRIntec**	9.4	18.7%	3.2%	73.5%	293.7	12/87
94	**Genicom**	9.4	105.6%	3.1%	37.8%	302.2	12/87
95	**Marshall Industries**	9.2	-14.8%	3.2%	143.7%	286.6	5/87
96	**Micom Systems**	9.1	8.1%	4.6%	45.7%	196.7	3/87
97	**ISC Systems**	8.8	29.3%	5.2%	68.4%	168.5	6/87
98	**Coherent**	8.5	-4.4%	5.3%	222.4%	159.0	9/87
99	**Diebold**	8.4	-43.3%	1.9%	29.7%	439.1	12/87
100	**Fluke**	8.3	-8.3%	4.0%	66.9%	206.3	9/87

Source: ELECTRONIC BUSINESS

(Continued)

Top capital spenders by segment

Capital expenditures FY 1987	Total ($ millions)	As a percentage of revenue
Semiconductors		
Motorola	$658.0	9.8%
Texas Instruments	462.8	8.3%
Intel	301.5	15.8%
LSI Logic	174.5	66.6%
Advanced Micro Devices	137.9	13.8%
National Semiconductor	94.7	5.1%
Harris	83.6	4.0%
VLSI Technology	50.1	29.1%
Gould	49.0	5.2%
Analog Devices	43.0	11.6%
Western Digital	40.6	8.8%
International Rectifier	6.0	4.0%
Total, weighted avg.	**$2,101.7**	**9.8%**
Communications		
Motorola	$658.0	9.8%
General Instrument	63.2	8.0%
M/A-COM	26.7	6.1%
Avantek	24.4	11.4%
DSC Communications	23.2	7.4%
Bolt Beranek and Newman	22.2	9.5%
Digital Communications	19.0	10.5%
General DataComm	15.3	7.6%
Dynatech	12.6	4.1%
Paradyne	12.2	5.2%
Andrew	11.7	5.2%
ADC Telecommunications	11.1	6.7%
Micom Systems	9.1	4.6%
Scientific-Atlanta	6.7	1.4%
3Com	6.3	5.7%
TIE/communications	4.3	1.7%
Aydin	4.1	2.8%
Dynascan	1.7	0.9%
Total, weighted avg.	**$931.8**	**8.2%**
Minicomputers		
IBM	$4,304.0	7.9%
DEC	748.4	8.0%
Hewlett-Packard	507.0	6.3%
Data General	142.9	11.2%
Tandem Computers	142.4	13.7%
Prime Computer	100.5	10.5%
Sun Microsystems	76.1	14.2%
Apollo Computer	53.7	9.7%
Gould	49.0	5.2%
Stratus Computer	13.8	7.5%
MAI Basic Four	13.2	4.1%
Computer Consoles	4.9	3.3%
Total, weighted avg.	**$6,155.9**	**7.9%**
Office equipment		
IBM	$4,304.0	7.9%
Xerox	937.0	9.1%
NCR	389.2	6.9%
Pitney Bowes	251.8	11.2%
Wang Laboratories	128.0	4.5%
Harris	83.6	4.0%
Datapoint	25.6	8.2%
Diebold	8.4	1.9%
Savin	1.2	0.3%
Total, weighted avg.	**$6,128.7**	**7.8%**
Mainframes		
IBM	$4,304.0	7.9%
Unisys	720.9	7.4%
NCR	389.2	6.9%
Control Data	178.3	5.3%
Amdahl	157.8	10.5%
Cray Research	40.2	5.8%
Total, weighted avg.	**$5,790.4**	**7.7%**
Components		
AMP	$171.8	7.4%
Molex	49.5	12.8%
AVX	31.8	11.7%
Augat	29.4	9.4%
Sprague Technologies	24.3	5.6%
Cherry Electrical	15.4	9.6%
CTS	13.4	5.1%
BRIntec	9.4	3.2%
Oak Industries	6.2	3.4%
Total, weighted avg.	**$351.2**	**7.6%**
Software		
Microsoft	$58.0	16.8%
Lotus Development	26.6	6.7%
Oracle Systems	16.9	12.9%
Mentor Graphics	14.7	6.6%
Cullinet Software	11.0	6.3%
Computer Associates	10.4	3.4%
Ultimate	7.9	4.6%
Ashton-Tate	6.5	2.4%
Total, weighted avg.	**$152.1**	**7.5%**
Microcomputers		
IBM	$4,304.0	7.9%
Compaq Computer	113.3	9.3%
Tandy	93.1	2.7%
Apple Computer	86.1	3.2%
Zenith Electronics	55.4	2.3%
Altos Computer	28.9	18.8%
Tandon	12.1	4.2%
AST Research	6.3	3.0%
Atari	4.1	0.8%
Total, weighted avg.	**$4,703.3**	**7.2%**
Peripherals		
Storage Technology	$179.2	23.9%
Control Data	178.3	5.3%
Seagate Technology	78.4	8.2%
MiniScribe	50.5	13.9%
Applied Magnetics	25.7	12.1%
Micropolis	22.3	7.7%
Maxtor	17.4	9.9%
Tandon	12.1	4.2%
Dataproducts	11.0	3.2%
Genicom	9.4	3.1%
Wyse Technology	8.1	3.1%
AST Research	6.3	3.0%
Quantum	5.9	4.9%
Cipher Data Products	5.8	3.3%
Decision Industries	4.9	2.6%
Intelligent Systems	2.8	1.7%
Xidex	2.2	0.4%
Total, weighted avg.	**$620.2**	**7.1%**
Government		
Motorola	$658.0	9.8%
GM Hughes Electronics	469.4	4.5%
Texas Instruments	462.8	8.3%
Honeywell	304.2	4.6%
Litton Industries	242.8	5.5%
Harris	83.6	4.0%
Singer	78.7	4.1%
E-Systems	51.1	4.2%
Gould	49.0	5.2%
Varian Associates	46.2	4.7%
Loral	34.2	5.0%
SCI Systems	29.6	5.4%
Cubic	17.1	4.7%
Watkins-Johnson	12.3	4.7%
Aydin	4.1	2.8%
Logicon	3.8	1.9%
Total, weighted avg.	**$2,547.0**	**5.9%**
Capital equipment		
Hewlett-Packard	$507.0	6.3%
Tektronix	66.8	4.8%
Perkin-Elmer	66.5	5.0%
Varian Associates	46.2	4.7%
Teradyne	41.0	10.8%
LTX	13.6	11.3%
GenRad	11.6	6.0%
Applied Materials	11.5	6.6%
Gerber Scientific	10.6	4.7%
Fluke	8.3	4.0%
Sun Electric	4.6	2.3%
Esterline	2.7	1.0%
Total, weighted avg.	**$790.3**	**5.8%**
Computer-based systems		
Hewlett-Packard	$507.0	6.3%
Honeywell	304.2	4.6%
Intergraph	43.7	6.8%
Recognition Equipment	21.7	8.2%
Gerber Scientific	10.6	4.7%
ISC Systems	8.8	5.2%
Coherent	8.5	5.3%
Measurex	6.9	3.0%
Sun Electric	4.6	2.3%
Total, weighted avg.	**$916.0**	**5.5%**
Medical		
Medtronic	$28.4	5.7%
Westmark International	10.5	3.6%
Diasonics	8.1	3.0%
Total, weighted avg.	**$47.0**	**4.4%**
Distributors		
Avnet	$47.3	3.1%
Marshall Industries	9.2	3.2%
Wyle Laboratories	3.8	1.0%
Pioneer-Standard	2.3	1.1%
Arrow Electronics	2.2	0.4%
Anthem Electronics	0.9	0.5%
Total, weighted avg.	**$65.7**	**2.1%**

Source: ELECTRONIC BUSINESS

Distributors are back on track after two-year slump

Led by a booming semiconductor demand, electronics distributors' sales are climbing. But a market consolidation could hurt the smaller players

BY DWIGHT B. DAVIS

After two years of being battered by the mid-80s electronics industry slump, industrial distributors struggled back to their feet in 1987. The year finished strongly despite a weak start, with distributor sales surpassing the $7 billion mark for the first time. The recovery has continued this year — thanks in large part to the booming semiconductor sector — and most distributors expect the resurgence to stretch well into 1989.

Based on estimates that the semiconductor industry will grow 25% to 30% during 1988, Prudential-Bache Securities Inc. predicts that distributors will experience a 20% revenue surge this year, up to a total of $8.4 billion. Wall Street's Bear Stearns & Co. is a little less bullish, predicting roughly 13% growth to a $7.9 billion level. Semiconductor sales traditionally account for about 40% of total distribution revenue, although the percentage has been slightly lower in recent years. Prudential-Bache sees the overall market growth continuing at a still respectable 15% rate in 1989, according to analyst Elizabeth Dorsey.

Economic slowdown may not be as important to distributors as the simple issue of component supply and demand, says Schweber president Mike Worfolk

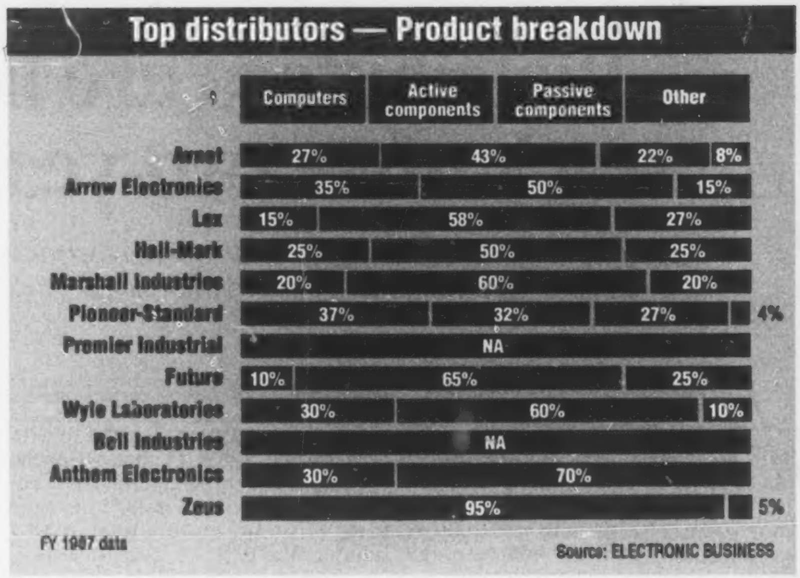
Jonathan Levine

Other observers expect somewhat lower growth next year, based partly upon widely held assumptions that 1989 may play host to a cyclical economic contraction. But distributors should be well positioned to continue slow growth even in a recessionary environment, as long as they are better able to manage their inventories than during the previous downturn, says Toby Mack, executive vice president of the National Electronic Distributors Association (NEDA).

In any case, a general economic slowdown may not be as important to distributors as the simple issue of component supply and demand, notes Mike Worfolk, president of Schweber Electronics. He points out that most of the growth in the first half of 1988 was fueled by product shortages and increased prices, not by higher levels of unit shipments. Given that component supplies are expected to improve toward year-end and into 1989, Worfolk expects growth in the 5% to 10% range in 1989.

Gross profit margins, meanwhile, hovered around 23% in 1987, Dorsey says, below the 25% margins typical in strong years. Profit margins should approach their traditional levels this year, she predicts, due in part to the continuing DRAM shortage, keeping prices of that key commodity high. As a caveat to this predicted improvement, however, Dorsey notes that an increased reliance on systems sales with their lower margins could adversely affect overall profits.

Downward pressure could also be exerted on margins as more suppliers attempt to cut their costs by reducing the number of OEM customers with



Top distributors — Product breakdown

FY 1987 data

Source: ELECTRONIC BUSINESS

which they deal directly, says Tom Calder, vice president for marketing at Marshall Industries. "As these suppliers turn more to industrial distributors, competition in the field will increase," he says, "and that will keep margins tight."

While distributors believe the worst is behind them, the 1985-86 recession has had a lasting impact on the nature of their business. Gone are the days when the companies could profit by doing little more than stocking large inventories and providing one-stop shopping for OEMs and other value-added resellers. Suppliers are now demanding that the middlemen keep them better informed about shifts in customer demand. At the same time, "Our customers are energetically trying to reduce their expenses by calling upon us to perform a variety of value-added services," says Anthony Hamilton, chairman of Avnet Inc.

Market restructuring

These market demands have begun to alter the basic character of the distribution business. Market consolidation has accelerated as the players attempt to gain greater economies of scale, more diverse product lines, and broader geographic representation. At the same time, the major distributors are branching out by providing value-added services such as component customization, testing and inspection; by setting up electronic data interchange (EDI) connections with their suppliers and customers; and by increasing their activity in the fast-growing systems sales marketplace.

The just-in-time production philosophy is playing a key role in much of this restructuring. OEMs and other integrators are looking to cut their inventory costs by keeping on-site stocks at a bare minimum. As such, they're relying upon distributors to keep the necessary components and peripherals in their warehouses ready for immediate shipping to keep the production pipeline flowing. To further expedite this process, many distributors are setting up "in-house stores" at their customers' sites. The distributor owns these inventories, but the customer agrees to maintain them on-site for rapid availability.

JIT arrangements not only require that the distributors provide all necessary components at a moment's notice, but that the parts arrive at the customers' doors error free. To meet this demand, distributors have beefed up their quality control and inspection departments, removing these responsibilities from their customers' shoulders.

Another related service, that of "kitting," is also much in demand. Kitting can range from simple prepackaging and shipment of related groups of components to actual subsystem assembly and programming. Schweber's Worfolk notes that the term "preproduction" might better describe the kitting operation. "We can source the production and deal with the 30 to 40 vendors supplying parts rather than have our customers perform that task," he explains.

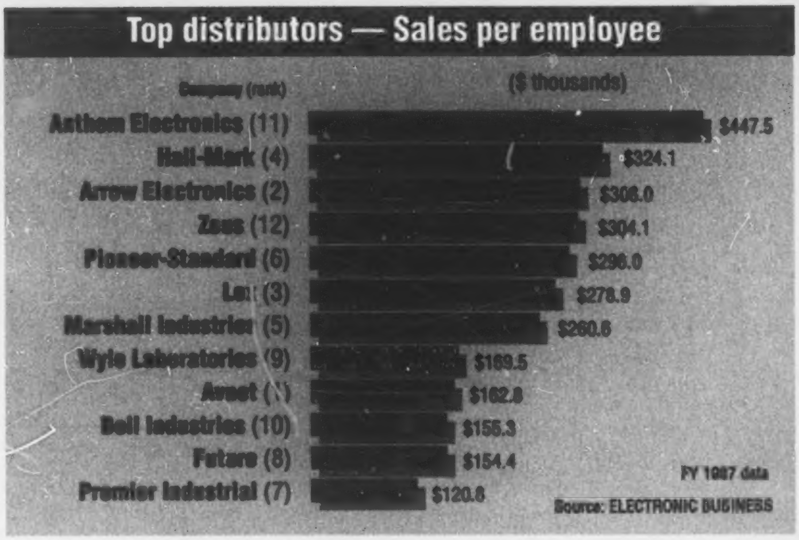
Distributors hope for a 15% to 20% surge in revenue and better profit margins

Communications networks

To efficiently manage these expanded activities, distributors are setting up on-line connections between themselves and their suppliers and customers. Through such EDI programs, "we're working to facilitate the information flow," says Hall-Mark Electronics president Joe Semmer. "Our customers load us up with orders, and we, in turn, load up our suppliers with orders."

So far, though, most EDI setups consist only of customer-site terminals linked to the distributors' mainframes. While these facilitate ordering and the transfer of technical product information, they fall far short of the full potential of EDI, says Worfolk. That potential will only be realized through the advent of mainframe-to-mainframe links that will let customer and distributor host computers communicate directly, he says. Such links will further augment ordering and invoicing automation, but they must wait until EDI communications standards are hammered out by groups such as the American National Standards Institute.

Even with the growing emphasis on electronic links between the parties, the distributors still lack good methods with which to monitor and analyze fluctuations in supplier and customer inventories, says Mack at the NEDA. As long as this is the case, he warns, the industry will be vulnerable to rumors about impending parts shortages and to the double and triple bookings that customers place to protect themselves when supplies get tight. "A better tracking model would go a long way toward damping out the wide inventory gyrations that have occurred in the past," Mack says. ▷


Top distributors — Sales per employee

Source: ELECTRONIC BUSINESS

For their part, distributors are struggling to maintain market share and improve profit margins in a dynamic business that is increasingly dominated by a few large players. Longtime leader Avnet accounted for about $1.3 billion of the industry's $7.4 billion total sales in calendar year 1987, up 12.1% from the previous year's revenue.

Avnet's Hamilton/Avnet division hopes to hold its lead in part through a restructuring move that separates its electronic components business from its growing computer systems and peripherals business. The company has virtually completed a major inventory centralization, with a flagship "megawarehouse" in Chandler, Ariz. Also in Chandler is a new IBM 3090-200E mainframe, which is being networked to the company's 4,000 nationwide terminals.

Small firms get squeezed

"The ability of the large distributors to feed off a few centralized warehouses permits them to set up simple sales offices rather than complete inventories around the country," notes Fred Wolf, an analyst with Mabon, Nugent & Co. "This gives them better cost efficiencies and may result in the squeezing out of some of the smaller distributors," he says.

Arrow Electronics Inc. also increased its revenue 12.1% in 1987, to a total of $562 million. The company lost $15.8 million on those sales, but that bad news was quickly mitigated as Arrow successfully completed its acquisition of the distribution units of Ducommun Electronics Inc. this January. If the 1987 sales of these units — Kierulff Electronics, Ducommun Data Systems and MTI Systems — had been combined with Arrow's, the resulting revenue would have totaled about $940 million.

The success with which Arrow has combined its new and old operations has surprised competitors and analysts alike. The company's average daily order rate rose from $2.6 million during 1987's fourth quarter to $4.6 million in this year's first quarter. That rate surpassed the combined preacquisition order rates of the two companies, and analyst Dorsey believes Arrow should easily attain its stated goal of reaching $1 billion in revenue this year. "They've

Top U.S. electronics distributors

1987 rank	Company	Calendar year distribution revenue ($ millions) 1987	1986	Percentage change	Distribution as a percentage of total company revenue	FY 1987 revenue ($ millions)	FY 1987 pretax profit ($ millions)	Pretax profit as a percentage of total revenue	FY 1987 net income ($ millions)
1	Avnet	$1,285	$1,146	12.1%	77%	$1,547.1	$46.6	3.0%	$22.8
2	Arrow Electronics[1]	562	502	12.1%	100%	562.4	-15.8	-2.8%	-15.8
3	Lex[2]	541	501	8.0%	23%	541.0	5.6	1.0%	NA
4	Hall-Mark	475	385	23.5%	100%	475.4	-9.5	-2.0%	-6.1
5	Marshall Industries	356	269	32.1%	100%	286.6	11.0	3.8%	5.1
6	Pioneer-Standard[3]	320	276	15.9%	100%	254.6	8.6	3.4%	5.2
7	Premier Industrial	297	267	11.2%	61%	459.0	81.4	17.7%	48.3
8	Future	270	217	24.3%	100%	270.2	NA	NA	3.0
9	Wyle Laboratories	265	225	18.2%	72%	368.0	10.5	2.9%	5.8
10	Bell Industries	199	158	25.9%	49%	357.1	6.9	1.9%	3.3
11	Anthem Electronics	197	167	17.8%	100%	196.9	9.1	4.6%	5.0
12	Zeus	91	92	-0.7%	100%	89.1	-1.7	-1.9%	-1.0

[1] Acquired Ducommun's distribution business Jan. 1988. If the acquisition had been made on Jan. 1, 1987, pro forma combined sales would have been $940 million
[2] Data for U.S. distribution operations only
[3] Includes sales of 50% owned Pioneer/Technologies Group Inc. with fiscal 1986 sales of $91.7 million

done an amazing job of assimilating the two companies," she says.

The downside of the acquisition is the further leveraging of the parent company. In 1987, Arrow's debt as a percentage of total capital was 39.5%; after the acquisition it rose to about 66%, according to Dorsey. Arrow had to pay $7.2 million in interest in the first quarter of this year.

Troubling high debt

High debt as a percentage of total capital is endemic in the industry — typically spanning the 35% to 45% range — and analysts warn that distributors might have a hard time financing their operations should another slump occur. Still, this year's strong economic performances should help lower this statistic.

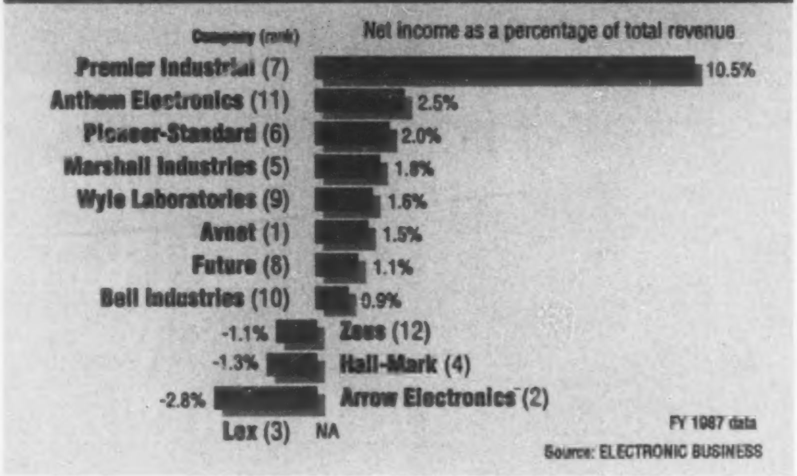
Another factor boosting this year's outlook is the impact of the 1986 Tax Reform Act. In fiscal year 1987, Avnet's net income fell from the previous year — from $23.9 million to $22.8 million — largely because its tax rate rose from 43.6% in fiscal '86 to 51.1% in fiscal '87. For the fiscal year closed June 30, 1988, Avnet's rate fell to about 39%.

No. 3 distributor Lex Services Plc announced a major restructuring of its Schweber Electronics division in mid-July. The changes include realignment of the firm's five regions and the establishment of sales and marketing, technology, regional services and operations managers for each region.

The fourth largest distributor, Hall-Mark, went against the consolidation trend in early July when its management team announced a plan to buy the company from parent Tyler Corp. Previously, Hall-Mark had been the subject of much takeover speculation. At press time, the deal had been signed, but not yet finalized, according to Semmer.

Fifth-ranked Marshall out-performed the rest of the top companies in 1987, with revenue jumping 32.1% over calendar year 1986 sales. The company continues to rely heavily upon its Japanese sourced product lines; approximately 19% of Marshall's 1987 sales were of Japanese products, making the company the largest distributor of these lines in the United States, according to marketing vice president Calder. ☐

Top distributors — Net income/total revenue



FY 1987 data

Source: ELECTRONIC BUSINESS

Net income as a percentage of total revenue	Return on equity	Return on investment	Cost of goods as a percentage of revenue	Sales per employee ($ thousands)	Net income per employee ($ thousands)	Five-year growth (Compounded average annual growth rate) Revenue	Net income	Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Fiscal year ended
1.5%	3.5%	2.6%	73.5%	$162.8	$2.4	6.8%	-16.5%	146.5%	25.7%	6/87
-2.8%	-16.4%	-10.0%	79.4%	308.0	-8.7	5.8%	NM	-13.0%	39.5%	12/87
NA	NA	NA	NA	278.9	NA	20.7%	NA	NA	NA	12/87
-1.3%	NA	NA	77.7%	324.1	-4.2	25.2%	NA	NA	NA	12/87
1.8%	9.4%	5.1%	75.1%	260.6	4.7	19.4%	NM	143.7%	45.7%	5/87
2.0%	15.4%	5.8%	75.2%	296.0	6.1	16.5%	53.7%	27.5%	62.5%	3/88
10.5%	18.1%	17.6%	51.5%	120.8	12.7	6.7%	6.9%	10.7%	2.5%	5/87
1.1%	NA	NA	NA	154.4	1.7	25.0%	-5.1%	NA	NA	12/87
1.6%	6.5%	4.3%	76.7%	169.5	2.7	13.4%	NM	49.1%	33.5%	1/88
0.9%	3.1%	2.4%	75.0%	155.3	1.4	11.8%	-15.3%	87.4%	23.0%	6/87
2.5%	7.3%	6.7%	76.7%	447.5	11.4	38.5%	27.3%	15.0%	7.5%	12/87
-1.1%	-5.9%	-2.4%	76.6%	304.1	-3.3	14.9%	NM	-461.6%	59.1%	9/87

NA = Not available
NM = Not meaningful

Source: ELECTRONIC BUSINESS

Since Black Monday, the spotlight's been on ROI

Suddenly, investors are concerned. And when Wall Street talks, everyone listens. High-technology firms like Cray and Compaq are focusing on ROI and ROE as well

BY RAY WISE

Generating high rates of return on investment can help a technology company keep growing and enhance the attractiveness of its shares, especially in a nervous stock market. And since October of 1987, the market has been nervous indeed. So, while investor concern over return on investment and equity appeared minimal during Wall Street's "trip to the moon on gossamer wings," these traditional measures have become increasingly important since that trip's disastrous end on Black Monday. "Investors are paying a lot more attention to such fundamentals as ROI and ROE," reports Rich Spillane, who runs the Fidelity Select Portfolio in Boston.

Last year, U.S. industry averaged a 10% return on investment. Even in technology, where returns tend to be above average, 20% is considered high. Yet, Minneapolis-based Cray Research Inc. produced an ROI of 20.2% in 1987 and 21.7% the previous year. Meanwhile, Compaq Computer Corp., with headquarters in Houston, last year boosted ROI to 24.8% from the year-earlier 16.7% and expects another 20%-plus performance this year. And Western Digital Corp., Irvine, Calif., attained a 20.3% ROI in 1987, a quantum leap from the year-earlier 13%. And leading software companies' ROIs hover around 30%.

A variety of factors can contribute to increased ROI. Finely honed forecasting techniques and careful capital marketing financing certainly help. Moreover, Cray is an example of one of the most important factors in keeping ROI high: product differentiation.

"Cray is the highest of high technology," says Warren K. Greene, president of the American Investors group of mutual funds in Greenwich, Conn. "Once you have reached that level, it is hard for anybody, even the Japanese, to catch you. Cray is in a world of its own."

While Cray's chief financial officer, John F. Carlson, does not shrug off the competition so readily, he generally agrees with Greene's assessment. "We are a single-product company with a clear vision," Carlson says. "Our products help customers do things they could not otherwise do. And to continue that product dominance, we spend 15% of revenues on research and development."

ROI leader Cray Research Inc.'s CFO John Carlson: "We are a single product company with a clear vision"

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Product superiority can push up ROI because profitability reflects price, and price is driven by the product. Cray's supercomputers can simulate the effect of a wind tunnel in the design of an aircraft; test the durability of an auto without smashing it into a brick wall; and help oil companies find and recover petroleum deposits with maximum efficiency. Until now, it's been difficult for customers to find a cheaper model. Consequently, Cray has two-thirds of the worldwide supercomputer market, including an awesome 80% outside Japan. And the firm's machines fetch $2.5 million to $20 million each.

More than ever before, though, Cray is facing competition. In Japan, Hitachi Ltd. and NEC Corp. are making supercomputers, and Fujitsu Ltd. is also having a go at it. IBM would like to enter the market, Carlson says, but probably not the high end, which is Cray's exclusive turf. But Cray wants more volume in the middle because, according to Carlson, "it is questionable how much more the top end can grow."

Another company benefiting from a high degree of product differentiation is Compaq Computer Corp, mainstay of the portable computer business and a big player in the IBM-compatible desktop market. Long term, company officials say, returns should be boosted even higher than the current high rates by a recently unveiled product at the high end of the desktop computer line.

Compaq's high returns are the result of sound growth management, according to Daryl J. White, corporate controller. And that in turn, he says, is at least partially due to the company's deft timing of capital financings. Unless this cycle is finely tuned, a company can wind up with overcapitalization and excess capacity, or undercapitalization and too little capacity. Complicating matters are the vagaries of the capital markets and the necessity of responding swiftly when a market window opens.

Encountering a window in the bond market last spring, Compaq sold $200 million of 6.25% convertible debentures, raising its long-term debt to a highly respectable 25% of total capitalization. The capital structure of an average manufacturing company is 50% equity, 50% debt. Debt is cheaper than equity, says White, "and so you waste corporate resources by expanding with equity capital alone."

Compaq's growth has been dizzying recently, with 1988 sales expected to surge nearly 60% to $1.9 billion from last year's $1.2 billion — and this can cause problems. "When you are growing at such a rapid pace, in general, selling and administrative expenses can accelerate extremely fast," says White.

Another strong advocate of finely honed forecasting is Bert Moyer, CFO of Western Digital, whose sales of board-level subsystems and other products soared 66% last year and should jump a similar amount in 1988. "You have to forecast where your business is going," Moyer urges. "We like to keep our expansion a little short of our expectations." Moyer says some CFOs, to their eventual sorrow, seek to keep slightly ahead of demand. But then "only slightly" turns into "more than slightly."

Exacerbating this is the rapidly changing technology of the capital equipment itself and the corporate love affair with staying on the leading edge of manufacturing know-how. "We tend to get wrapped up in our own technology," says Moyer, who stresses that attainment of maximum manufacturing efficiency can be an outright error, depending on whether the corporate strategy is to achieve cost leadership, product differentiation or market focus.

"Only when you seek cost leadership does it make sense to try to keep on the leading edge of manufacturing cost control," Moyer advises. According to this view, a product differentiation company like Cray or Compaq, or a market-focus enterprise like Sun Microsystems Inc., which concentrates intensely on the engineering marketplace, does not need to invest heavily in production cost control.

As a product's sales volume expands, a shift from product differentation to a cost-leadership strategy may be called for, according to Moyer. "When the market for a product enlarges substantially, competition is attracted and cost becomes a factor.

Moyer cites Western Digital's entry into the manufacture of video graphics components. To attain market penetration for the line, the company adopted a product differentiation approach. As volume expanded, Western Digital invested heavily in manufacturing capability to drive prices down and competitors out. As a result, Western Digital now has a huge 65% share of the $400 million market for video graphics components.

Compaq's controller Daryl White: Look for the open window in the capital markets

In part, returns on investment and equity reflect the corporate asset base, which determines the size of the denominators in the ratios. All other things being equal, it would be unreasonable to expect an integrated steel company to generate returns as high as a consulting firm or advertising agency. Return on investment (ROI) measures how efficiently management uses corporate assets and how well it preserves shareholder values. It is the ratio of net earnings to the total capital employed in the business, often consisting of both debt and equity. In the absence of long-term debt, ROI equals return on equity (ROE).

Viewed as a manufacturing company, Apple Computer Inc. would inspire awe for its 26% return on investment last year and its prospects for topping 30% in 1988. But, in fact, Apple farms out so much of its manufacturing that it qualifies as an organization of product designers. It does however, invest in people, rather than plant and equipment, with the emphasis on sales representatives and customer engineers. "We have 100 such people today and would like to have 200," says Deborah Coleman, Apple's CFO. Apple has advanced from selling just boxes to selling marketing solutions to customer problems, a transformation that mandates expansion of the field force.

If Apple is people-oriented, the software industry is even more so. "Our capital requirements are far different from those of a hardware company," says Jeffrey L. Walker, senior vice president and chief financial officer of Oracle Systems Corp. "We invest in people rather than in plants. Essentially, we have no capital requirements."

Lotus Development Corp. employs 2,400, more than 70% of them professionals, and keeping the workforce satisfied is a major corporate priority, as evidenced by annual employee opinion surveys that sound out attitudes toward management. Lotus also makes a point of determining the needs and problems of its customers. Major clients, for example, are brought into corporate headquarters in Cambridge, Mass., for executive briefings. "It seems to work," according to Martin Fahey, director of investor relations. "We've sold 4 million spreadsheets and they are being used by 7 million to 8 million people."

There is a limit to how much a software firm can reinvest in itself by hiring people, says CFO Frank Gaudette of Microsoft Corp., "because people can be absorbed only so fast. However, we are in a growth mode and we are hiring." □

Top ROI performers in U.S. electronics

Rank	Company	Return on investment		Return on equity		Fiscal 1987 sales ($ millions)	Fiscal 1987 profits ($ millions)	Fiscal year ended
		1987	1986	1987	1986			
1	**Lotus Development**	30.0%	32.8%	35.7%	42.1%	$395.6	$72.0	12/87
2	**Oracle Systems**	29.3%	16.1%	31.9%	18.9%	282.1	42.9	5/88
3	**Microsoft**	29.2%	28.2%	30.1%	28.2%	345.9	71.9	6/87
4	**Apple Computer**	26.0%	5.7%	26.0%	5.7%	2,661.1	217.5	9/87
5	**Compaq Computer**	24.8%	16.7%	34.1%	23.4%	1,224.1	136.3	12/87
6	**Ashton-Tate**	23.0%	22.9%	24.1%	24.6%	267.3	43.1	1/88
7	**Seagate Technology**	21.3%	15.4%	39.5%	16.6%	958.1	139.7	6/87
8	**Western Digital**	20.3%	13.0%	21.2%	22.8%	462.5	42.8	6/87
9	**Cray Research**	20.2%	21.7%	24.1%	28.2%	687.3	147.1	12/87
10	**Inmac**	20.0%	19.8%	22.9%	34.8%	165.4	7.7	7/87
11	**ADC Telecommunications**	19.3%	18.7%	20.1%	19.8%	166.9	15.3	10/87
12	**Medtronic**	19.0%	17.4%	21.9%	19.1%	653.3	86.5	4/88
13	**NCR**	17.7%	13.0%	19.4%	14.0%	5,640.7	419.3	12/87
14	**MAI Basic Four**	17.6%	15.9%	29.3%	31.4%	321.0	22.8	9/87
15	**Stratus Computer**	17.6%	16.3%	18.9%	17.9%	184.2	19.4	12/87
16	**DEC**	17.3%	10.1%	18.1%	10.8%	9,389.4	1,137.4	6/87
17	**Digital Communications**	17.2%	17.3%	17.2%	17.3%	181.4	27.0	6/87
18	**Computer Associates**	16.4%	9.2%	20.4%	14.5%	709.1	101.8	3/88
19	**Intelligent Systems**	16.4%	0.1%	24.7%	0.1%	163.2	10.2	12/87
20	**AMP**	16.3%	12.4%	18.5%	14.5%	2,317.8	249.7	12/87
21	**Gerber Scientific**	15.6%	11.7%	17.5%	13.1%	264.0	29.6	4/88
22	**Amdahl**	15.4%	5.7%	18.5%	7.9%	1,505.2	142.0	12/87
23	**Tandy**	15.3%	11.8%	17.6%	15.1%	3,452.2	242.3	6/87
24	**Measurex**	15.2%	13.3%	15.8%	13.9%	227.4	26.8	11/87
25	**Tandon**	15.2%	-101.4%	18.3%	-122.7%	289.1	17.1	12/87
26	**Logicon**	15.0%	10.5%	15.0%	10.5%	218.9	9.1	3/88
27	**Tandem Computers**	14.4%	11.7%	14.6%	11.9%	1,035.5	105.6	9/87
28	**Atari**	14.2%	23.3%	26.3%	23.8%	493.2	44.2	12/87
29	**3Com**	14.0%	12.9%	14.4%	13.2%	251.9	22.5	5/88
30	**MiniScribe**	14.0%	22.3%	27.8%	30.6%	362.5	28.1	12/87
31	**Pitney Bowes**	13.5%	14.3%	19.2%	18.2%	2,250.5	199.4	12/87
32	**Molex**	13.3%	12.0%	13.7%	12.6%	386.8	43.4	6/87
33	**AST Research**	13.1%	31.0%	13.1%	31.4%	206.0	13.0	6/87
34	**Micropolis**	12.7%	16.5%	19.6%	16.5%	288.3	27.2	12/87
35	**Intergraph**	12.2%	13.7%	12.3%	14.2%	641.1	69.9	12/87
36	**Dynatech**	12.1%	14.1%	16.1%	19.2%	367.8	24.5	3/88
37	**Diasonics**	12.1%	-18.8%	14.4%	-22.7%	267.6	15.2	12/87
38	**Watkins-Johnson**	12.0%	13.3%	14.7%	16.8%	264.3	17.1	12/87
39	**IBM**	12.0%	12.0%	13.7%	13.9%	54,217.0	5,258.0	12/87
40	**E-Systems**	11.8%	13.8%	14.1%	16.3%	1,227.2	60.4	12/87
41	**Scientific-Atlanta**	11.6%	-4.3%	12.0%	-5.1%	495.3	24.3	6/87
42	**Marshall Industries**	11.4%	4.7%	15.8%	8.4%	420.4	17.6	5/88
43	**Aydin**	11.1%	10.7%	12.6%	11.6%	149.2	8.8	12/87
44	**Hewlett-Packard**	10.6%	10.9%	12.8%	11.8%	8,090.0	644.0	10/87
45	**Mentor Graphics**	10.5%	6.2%	10.8%	7.1%	221.8	20.3	12/87
46	**Diebold**	10.3%	10.6%	10.5%	10.9%	439.1	35.8	12/87
47	**Ultimate**	10.0%	14.5%	12.6%	15.5%	209.2	13.0	4/88
48	**Wyse Technology**	9.9%	10.2%	17.0%	19.6%	456.6	28.0	3/88
49	**Texas Instruments**	9.2%	2.0%	11.4%	2.3%	5,594.5	256.9	12/87
50	**Applied Magnetics**	9.2%	4.0%	9.5%	4.1%	211.9	14.2	9/87

(Continued)

Top ROI performers in U.S. electronics

Rank	Company	Return on investment 1987	Return on investment 1986	Return on equity 1987	Return on equity 1986	Fiscal 1987 sales ($ millions)	Fiscal 1987 profits ($ millions)	Fiscal year ended
51	**General Instrument**	9.1%	2.8%	12.0%	4.0%	$1,155.5	$66.2	2/88
52	**Dynascan**	9.1%	8.2%	14.5%	16.2%	191.6	6.6	12/87
53	**Sun Microsystems**	9.0%	9.4%	15.1%	11.0%	537.5	36.3	6/87
54	**Unisys**	8.7%	-0.7%	12.7%	-1.1%	9,712.9	578.0	12/87
55	**Intel**	8.5%	-10.9%	13.4%	-14.4%	1,907.1	175.5	12/87
56	**Motorola**	8.3%	5.7%	10.2%	7.0%	6,707.0	308.0	12/87
57	**Computer Consoles**	8.1%	-2.6%	29.9%	-23.1%	148.4	9.6	12/87
58	**Avantek**	7.5%	10.9%	7.5%	10.9%	213.7	11.6	12/87
59	**Xerox**	7.5%	6.8%	10.4%	9.5%	10,320.0	578.0	12/87
60	**Genicom**	7.5%	12.9%	21.5%	18.9%	302.2	12.6	12/87
61	**Harris**	7.4%	5.4%	8.6%	6.6%	2,079.0	84.5	6/87
62	**Altos Computer Systems**	7.4%	18.7%	9.1%	19.8%	153.9	9.7	6/87
63	**Loral**	7.0%	5.1%	17.0%	15.8%	1,440.8	74.3	3/88
64	**Honeywell**	7.0%	0.4%	11.3%	0.6%	6,679.3	253.7	12/87
65	**Anthem Electronics**	6.7%	7.5%	7.3%	7.5%	196.9	5.0	12/87
66	**GM Hughes Electronics**	6.7%	6.1%	7.4%	6.7%	10,481.0	521.1	12/87
67	**Cherry Electrical**	6.6%	2.8%	10.4%	4.4%	194.6	7.4	2/88
68	**Apollo Computer**	6.3%	3.0%	9.6%	4.9%	553.7	21.7	12/87
69	**CTS**	6.3%	-16.0%	8.3%	-22.8%	261.1	10.5	12/87
70	**Veeco Instruments**	6.2%	0.3%	9.2%	0.4%	195.6	9.2	9/87
71	**Prime Computer**	6.1%	10.3%	12.9%	10.7%	960.9	64.8	12/87
72	**Maxtor**	6.0%	9.8%	11.9%	20.4%	271.2	14.1	3/88
73	**National Semiconductor**	5.9%	-2.5%	6.2%	-2.8%	2,469.7	62.7	5/88
74	**Pioneer-Standard Electronics**	5.8%	2.2%	15.4%	6.3%	254.6	5.2	3/88
75	**Analog Devices**	5.6%	7.6%	6.1%	8.7%	370.4	18.7	10/87
76	**Recognition Equipment**	5.6%	6.0%	8.4%	9.1%	264.7	11.2	10/87
77	**ISC Systems**	5.4%	12.0%	6.5%	14.7%	168.5	6.5	6/87
78	**Litton Industries**	5.3%	2.8%	13.1%	7.0%	4,419.7	138.1	7/87
79	**Micom Systems**	5.3%	1.4%	5.6%	1.5%	223.4	9.8	3/88
80	**DSC Communications**	5.1%	3.3%	6.9%	5.5%	312.4	14.6	12/87
81	**SCI Systems**	5.0%	7.0%	12.0%	12.0%	552.9	16.0	6/87
82	**Augat**	4.8%	-3.6%	5.4%	-4.4%	313.2	11.5	12/87
83	**AVX**	4.8%	-1.5%	8.5%	-2.0%	271.9	15.8	12/87
84	**Oak Industries**	4.8%	-30.6%	7.2%	-50.7%	182.2	5.7	12/87
85	**Wyle Laboratories**	4.3%	4.8%	6.5%	5.3%	368.0	5.8	1/88
86	**Cubic**	4.1%	0.7%	7.1%	1.0%	361.8	7.9	9/87
87	**Varian Associates**	4.1%	-3.0%	4.9%	-3.6%	982.8	21.4	9/87
88	**BRIntec**	4.0%	8.6%	10.0%	21.5%	293.7	5.9	12/87
89	**VLSI Technology**	3.4%	0.0%	5.7%	0.0%	172.0	8.1	12/87
90	**Mark IV Industries**	3.1%	3.9%	18.4%	25.3%	403.0	17.0	2/88
91	**Wang Laboratories**	3.1%	2.3%	4.8%	3.5%	2,836.7	70.7	6/87
92	**Cipher Data Products**	3.1%	5.4%	3.1%	5.4%	178.2	4.3	6/87
93	**Gould**	3.0%	3.6%	5.2%	6.2%	933.4	25.0	12/87
94	**Avnet**	2.6%	3.1%	3.5%	3.7%	1,547.1	22.8	6/87
95	**Sun Electric**	2.5%	3.4%	4.1%	27.5%	203.9	3.3	10/87
96	**Andrew**	2.2%	5.7%	2.5%	6.6%	223.2	3.8	9/87
97	**LSI Logic**	2.2%	1.1%	3.5%	1.5%	262.1	10.7	12/87
98	**John Fluke**	1.7%	8.5%	1.9%	9.8%	206.3	2.0	9/87
99	**Control Data**	1.7%	-20.0%	2.4%	-31.0%	3,366.5	25.0	12/87
100	**Singer**	1.5%	6.2%	3.7%	9.6%	1,902.7	23.4	12/87

Source: ELECTRONIC BUSINESS

Well! Look who paid no '87 taxes to Uncle Sam!

IBM, AMD, Xerox and others actually got rebates from the IRS in 1987. But possible tax hikes and more complex rules spell headaches for high tech

They must have great tax attorneys. Last year, big wheels in the U.S. electronics industry — companies like Data General Corp., IBM and Zenith Electronics Corp. — not only paid no federal tax, but many received tax credits.

Part of the reason is that U.S. electronics firms are more reliant on foreign operations than ever before; for example, in 1987, almost all of IBM's tax provision went to governments overseas. In part, too, the rebates are thanks to deferred investment tax credits. But with the repeal of the investment tax relief laws, that's a situation that may not be repeated.

Indeed, increased tax-law complexities and the threat of budget-balancer tax increases from a new White House administration do not bode well for high tech. On average, electronics-industry taxes were already higher in 1987 than in the previous year.

The dust has yet to settle on the Tax Reform Act of 1986. With a technical corrections bill being hammered out in Congress and the Internal Revenue Service trying to interpret the bill, corporate America is doing its best to get a handle on what is going on. It is not an easy task.

According to the ELECTRONIC BUSINESS annual survey of the top electronics industry taxpayers for 1987, the figures are superficially encouraging (see chart). For the 130 companies on the list, the average effective tax rate dropped from 42.9% in 1986 to 39.4% in 1987. For the top 20 companies, all but six posted a decline in their effective tax rates between 1986 and 1987. Only those companies from the ELECTRONIC BUSINESS 200 [July 15, 1988] that derive at least 70% of their total revenue from electronics qualified for inclusion on this list.

BY BRUCE C.P. RAYNER
and LINDA STALLMANN

Not surprisingly, IBM was again the top electronics taxpayer, accounting for 39% of total 1987 tax provisions of the companies listed. In fact, IBM set more aside for taxes in 1987 than the next top 12 companies combined — but not a cent of that money is going to Uncle Sam. The Feds wound up *giving* Big Blue a credit of $113 million on its U.S. earnings of nearly $4 billion based on deferred investment tax credits of $141 million. Among the other 23 companies that came off clean with Uncle Sam were seventh-ranked Xerox Corp. and 37th-placed Perkin-Elmer Corp.

On the surface, the electronics industry has survived tax reform with minimal damage. True, the investment tax credit is no longer around, nor is the capital gains differential. But a watered down version of the research and experimentation (R&E) tax credit, a big perk for high tech, looks to be a shoo-in for a two-year extension. It is up to the congressional Joint Committee on Taxation to work out the details, but most high-tech Hill watchers are confident the R&E credit will survive.

Rebates all around...

Federal tax credit for fiscal 1987
($ millions)

IBM	$113.00
Perkin-Elmer	25.79
Teradyne	11.50
Zenith	11.00
Data General	9.11
Decision Industries	6.29
Xerox	6.00
Cipher Data	3.49
Esterline	3.31
Andrew	2.48
Micropolis	1.35
Sun Electric	1.22
[illegible]	0.81
Coherent	0.38
Applied Materials	0.31
Cherry Electrical	0.25
AMD	0.09

Sources: ELECTRONIC BUSINESS and company reports

However, taking a closer look behind glossy annual reports and industry aggregates reveals an unsettling picture of the aftermath of reform. For example, if IBM is taken off the ELECTRONIC BUSINESS top taxpayers list, the remaining 129 companies ended up by posting an *increase* in their average effective tax rate last year, from 35.7% in 1986 to 39.6% in 1987. Again, excluding IBM, the total tax burden increased by 67.8% between 1986 and 1987, while net income rose by 63%.

Too complex

Besides higher rates and more taxes, electronics companies insist the new law has added considerably to the administrative burden of doing business. "If you talk to the typical company chiefs, they will say that the complexity due to the transition is what strikes them the most, not that they are paying more or less in taxes as a corporation," comments James LeMunyon, a lobbyist for the American Electronics Association (AEA) in Washington, D.C.

Even the accountants are concerned. Reform has complicated their work to the point where they cannot function without a computer. The biggest culprits, they say, are the alternative minimum tax (AMT) and the new uniform capitalization rules. "You have to raise the question of whether or not our tax system has gone a little bit haywire if the only way you can get your tax compliance

Jean Francoise Allaux

done is by buying a computer program," comments Kent Schreiner, a principal in the Boston office of Ernst & Whinney, a Big Eight accounting firm.

Some high-tech tax experts warn that tax reform goes further than just higher bookkeeping costs. They complain that start-up activity is being hampered by the restrictions on net operating loss (NOL) carryforwards and a higher capital gains tax. Also, defense contractors are being squeezed as a result of the repeal of the completed contracts method of accounting, which used to allow a contractor to defer taxes. Without it, productivity, research and development and capital investment will drop significantly, defense industry leaders say. "It is like taxing a farmer as soon as he plants his crop," complains Don Fuqua, president of the Aerospace Industries Association. The drought in the defense business does not help either.

Tax reform is making itself felt on the international front too. Reform has lowered the U.S. tax rate below that of most trading partners, thus making international tax planning more critical for American companies that operate overseas. Because of the new rules, the complexity of international tax planning has also increased significantly. As a result, Big Eight accountants are recommending their clients reevaluate all their offshore operations.

Nowhere is this more evident than in electronics. For the ELECTRONIC BUSINESS top taxpayers, over 60% of 1987's taxes went to foreign governments, reflecting a significant reliance on offshore manufacturing and international markets. In the case of top taxpayer IBM, the foreign tax burden is even more pronounced. In 1987, 99.6% of IBM's tax provision went to foreign governments, even though only 54% of its products were sold overseas. This resulted in an effective foreign tax rate of 58.7% last year for Big Blue.

Despite the rhetoric from Washington about rebuilding America's international competitive position, tax reform has made it more difficult for U.S.-based high-tech companies to export, claims Mark Singer, a tax partner at the accounting firm of Price Waterhouse in San Jose. "I think it is almost a policy question that at a time when we are concerned with our balance of trade with other countries, some of the changes have discouraged exports from an economic standpoint," he says.

How to stifle foreign business

In particular, Singer points to limitations on foreign tax credits as an example of how tax reform is stifling foreign business. Also, various changes in the tax laws, such as the "super royalty," mean that operations in low-tax countries such as Ireland or Switzerland have become less attractive. In essence, the super royalty charges a license fee on technology transferred offshore based on the market value of the product that is being maufactured, a rate higher than companies previously had to pay.

"Super royalty is most likely bad tax policy," says Howard Slayen, a tax partner-in-charge at the San Jose/Menlo Park office of Coopers & Lybrand, a Big Eight accounting firm. Slayen complains that in its zeal to close a loophole, "Congress went too far in coming up with a system that is not rational and not in conformity with accepted international standards."

In an unrelated foreign tax issue, the Internal Revenue Service is changing its interpretation of how a company can pass title across international borders. Based on its interpretation of section 863(b) of the tax code, the IRS used to let companies transfer title outside the United States and use the foreign source income toward a tax credit on U.S. taxes. But now, the IRS is making it harder to claim that credit.

Given such a climate, most tax experts suggest close scrutiny of foreign operations as the first step toward more effective tax planning. However, because of the November election and the expected tax changes in 1989, the planning horizon should be kept short — no more than two or three years, the pencil pushers say.

Another possibility, says Ernst & Whinney's Schreiner, is for electronics companies to change the capitalization ratios in their foreign subsidiaries. A higher debt burden, he says, could be a way to save money. For instance, instead of issuing shares in the foreign company, make a loan from the U.S. parent. In this way, the subsidiary can take a tax deduction while the U.S. parent company pays a relatively lower tax rate in-country on the interest income it earns.

Back on the domestic front, a new Financial Accounting Standards Board (FASB) statement No. 96 is changing the way all corporations have to report their income taxes. The new rule is mandated to take effect on Dec. 15 of this year. Initially, FASB 96 had the support of the accounting community, but because of its complexity, many tax accountants have changed their opinion.

"There will be many high-tech companies whose earnings will be adversely affected by FASB 96, which, as a result, will be reporting higher income expense and lower earnings to the public," says Singer at Price Waterhouse. The lower earnings might prompt some companies to change their corporate planning strategies, he speculates.

In essence, the 100-page FASB statement forces corporations to report their deferred taxes to take into account any current or subsequent changes in tax rates. The reason is so that the balance sheet better reflects the true liability of taxes due, says an FASB spokesperson. But many accountants contend that the new ruling will create wild swings in the tax expense and on the bottom line. And with tax rates changing every few years, the fluctuations in the financial reports could distort the public's perception of the health of the company. According to Ernst & Whinney's Schreiner, FASB 96 will also affect how foreign taxes are reported, thus creating even more of a whiplash effect in company figures.

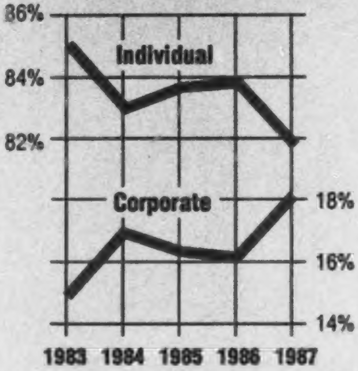
The next surprise

The whiplash will most likely be compounded. Corporate America's next surprise will be what the new president will do to reform the reform. Watch for the National Economic Committee's report, due out early next year, to set the stage for tax policy changes. Pundits expect the report will condone tax increases — possibly corporate rate increases — as one way to get a handle on the 1990 federal budget deficit.

The bottom line on tax reform

Corporations have been footing more of the tax bill...

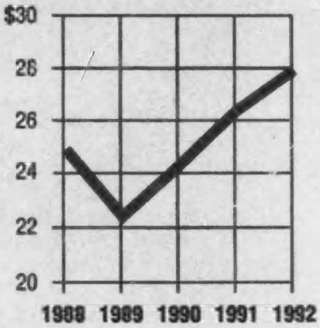
Percentage of income and profit taxes collected by the IRS



Source: IRS

...and tax reform isn't helping

Estimated additional tax revenue paid by U.S. corporations as a result of the Tax Reform Act of 1986 ($ billions)



Sources: Department of Treasury, Office of Tax Analysis

But for now, the best that tax planners can do is guess at what the tax laws will be like next year. Besides some vague generalities, neither presidential candidate is committing to concrete fiscal strategy. Vice President George Bush has said he would reinstate the 15% capital gains tax, but little else has been heard from either candidate.

Adding to the political uncertainty is the future chairmanship of the powerful Senate Finance Committee that is currently held by Texas senator and Democratic vice-presidential hopeful Lloyd Bentsen. If Massachusetts Gov. Michael Dukakis wins the presidential election, the chair will probably go to ranking Democrat Spark Matsunaga of Hawaii.

Whoever gets elected, the critical task ahead will be how to handle the federal budget deficit. Economists agree it will involve both raising taxes and lowering spending. David Wyss, chief financial economist at Data Resources Inc., expects some increase in "sin taxes" on tobacco and alcohol, but does not see much chance for a proposed value-added tax or even any significant change in the corporate tax rate. However, if Congress finds itself in dire need, "the corporate rate is one they are likely to come after," he says. Wyss also speculates on a drop in the capital gains tax to around 20%, down from its current 28% level, coupled with a leveling off of the top personal tax rates to around 32%.

It is still too early to have hard and fast numbers on the economic effects of tax reform. Even when the figures become available, it will be difficult to isolate those changes caused by tax reform. But one of the critical gauges that economists are watching is the rate of capital investment. Some doomsayers claim that tax reform has crippled manufacturing investment, while others point to healthy investment growth in early 1988 as proof that investment decisions are being made more on economic grounds than on the basis of favorable tax breaks. The reality is probably a combination of the two.

A study conducted by Gordon Richards, an economist at the National Association of Manufacturers in Washington D.C., estimates that $30 billion in gross national product growth has been wiped out by tax reform. The main reason for the drop was the one time increase in the cost of capital as a result of the repeal of the investment tax credit, he says.

But for the electronics industry, there have been mitigating circumstances that have helped to dampen the negative effects of tax reform, says Richards. The fall in the value of the U.S. dollar has spurred U.S. sales of computers and data-processing equipment, while the steady drop in prices of electronic equipment has offset the repeal of the ITC. For the present then, high tech should count itself lucky. ☐

Taxes paid by top electronics companies

		Total income tax provision (benefit) ($ millions)			1987 income tax provision (benefit) ($ millions)		
Rank	Company	1987	1986	Percentage change from 1986	Federal	State and local	Foreign
1	**IBM**	$3,351.0	$3,600.0	-6.9%	($113.0)	$128.0	$3,336.0
2	**DEC**	551.5	240.1	129.7%	297.1	48.7	205.8
3	**GM Hughes Electronics**	378.1	366.1	3.3%	319.3	62.3	(3.5)
4	**Unisys**	369.5	(48.4)	NM	186.6	24.1	158.8
5	**NCR**	343.1	283.2	21.2%	95.4	10.4	237.4
6	**Hewlett-Packard**	318.0	264.0	20.5%	82.0	37.0	199.0
7	**Xerox**	262.0	112.0	133.9%	(6.0)	6.0	262.0
8	**Tandy**	213.6	186.4	14.6%	193.5	17.7	2.4
9	**Apple Computer**	192.9	155.8	23.8%	146.2	27.9	18.9
10	**AMP**	180.8	129.7	39.4%	57.1	19.1	104.6
11	**Honeywell**	158.2	26.9	488.1%	79.0	14.7	64.5
12	**Texas Instruments**	157.8	59.0	167.5%	101.0	NA	57.0
13	**Amdahl**	125.0	29.5	323.7%	92.9	17.1	15.0
14	**Intel**	112.3	8.7	1,198.8%	67.3	14.9	30.1
15	**Litton Industries**	110.8	56.9	94.8%	86.5	15.3	9.1
16	**Motorola**	108.0	71.0	52.1%	65.0	17.0	26.0
17	**Pitney Bowes**	95.7	93.3	2.5%	51.3	13.7	30.7
18	**Compaq Computer**	92.7	31.9	190.6%	72.0	3.3	17.4
19	**Cray Research**	85.3	100.4	-15.0%	70.0	10.1	5.3
20	**Tandem Computers**	79.3	50.7	56.4%	45.0	12.4	21.9
21	**Tektronix**	51.9	3.0	1,628.3%	12.9	2.4	36.6
22	**Microsoft**	49.5	26.7	85.0%	NA	NA	NA
23	**Seagate Technology**	46.0	1.6	2,782.1%	35.6	10.4	0.0
24	**Intergraph**	45.9	53.1	-13.6%	32.4	3.4	10.1
25	**General Instrument**	41.7	11.2	272.3%	26.9	4.5	10.2
26	**Loral**	41.3	41.3	0.0%	37.0	4.3	0.0
27	**Harris**	37.9	1.1	3,323.3%	28.3	6.7	2.9
28	**E-Systems**	35.8	47.8	-25.1%	35.8	NA	NA
29	**Medtronic**	34.9	34.9	0.0%	17.9	4.6	12.4
30	**Ashton-Tate**	33.9	28.1	20.8%	21.5	6.7	5.7
31	**Sun Microsystems**	32.8	9.0	263.9%	17.4	5.8	9.7
32	**Control Data**	32.5	10.0	225.0%	7.4	3.5	21.6
33	**Molex**	32.0	21.3	50.3%	1.8	0.8	29.4
34	**Lotus Development**	30.9	22.7	35.8%	21.7	1.7	7.5
35	**Atari**	30.7	22.2	38.3%	25.4	0.1	5.1
36	**Computer Associates**	30.6	14.7	107.8%	18.2	2.5	9.9
37	**Perkin-Elmer**	24.8	39.7	-37.4%	(25.8)	1.4	49.3
38	**Scientific-Atlanta**	24.3	(6.4)	NM	20.9	1.2	2.2
39	**Avnet**	23.8	18.4	29.3%	20.0	3.9	0.0
40	**Gould**	23.2	22.5	3.1%	5.6	1.1	16.5
41	**Cullinet Software**	22.4	11.1	101.2%	21.6	0.7	0.1
42	**Prime Computer**	21.6	15.6	38.0%	14.1	1.3	6.2
43	**National Semiconductor**	19.5	14.5	34.9%	18.2	2.2	(0.9)
44	**Diebold**	19.4	21.8	-11.1%	16.8	2.6	—[1]
45	**Wang Laboratories**	19.0	5.0	280.0%	0.3	0.5	18.2

[1] Foreign and federal taxes reported together

NM = Not meaningful
NA = Not available

Effective tax rate		Fiscal 1987 revenue and income ($ millions)			Foreign revenue as a percentage of total revenue	Fiscal year ended	1987 ELECTRONIC BUSINESS 200 rank	Location
1987	1986	Total revenue	Income before taxes	Net income*				
38.9%	42.9%	54,217.0	8,609.0	5,258.0	54.0%	12/87	1	Armonk, N.Y.
32.7%	28.0%	9,389.4	1,689.0	1,137.4	47.0%	6/87	4	Maynard, Mass.
42.0%	45.1%	10,481.0	899.2	521.1	11.6%	12/87	3	Detroit, Mich.
39.0%	-52.7%	9,712.9	947.5	578.0	43.6%	12/87	5	Detroit, Mich.
45.0%	45.7%	5,640.7	762.4	419.3	54.6%	12/87	11	Dayton, Ohio
33.1%	33.8%	8,090.0	962.0	644.0	49.0%	10/87	8	Palo Alto, Calif.
31.2%	16.6%	10,320.0	840.0	578.0	44.9%	12/87	7	Stamford, Conn.
46.6%	48.2%	3,452.2	458.8	242.3	1.6%	6/87	17	Ft. Worth, Texas
47.0%	50.3%	2,661.1	410.4	217.5	27.1%	9/87	22	Cupertino, Calif.
42.0%	44.1%	2,317.8	430.5	249.7	52.3%	12/87	34	Harrisburg, Pa.
38.4%	67.6%	6,679.3	411.9	253.7	20.6%	12/87	10	Minneapolis, Minn.
38.1%	59.8%	5,594.5	414.7	256.9	31.5%	12/87	12	Dallas, Texas
46.8%	42.9%	1,505.2	267.0	142.0	44.3%	12/87	41	Sunnyvale, Calif.
39.0%	5.0%	1,907.1	287.9	175.5	38.8%	12/87	35	Santa Clara, Calif.
44.5%	44.4%	4,419.7	249.0	138.1	22.7%	7/87	20	Beverly Hills, Calif.
26.0%	26.8%	6,707.0	416.0	308.0	43.8%	12/87	9	Schaumburg, Ill.
41.9%	46.3%	2,250.5	228.7	199.4	19.5%	12/87	31	Stamford, Conn.
40.7%	41.7%	1,224.1	228.1	136.3	26.0%	12/87	47	Houston, Texas
36.7%	44.6%	687.3	232.4	147.1	37.0%	12/87	68	Minneapolis, Minn.
42.9%	44.3%	1,035.5	184.9	105.6	44.4%	9/87	52	Cupertino, Calif.
50.3%	7.1%	1,395.9	103.0	51.2	42.2%	5/87	44	Beaverton, Ore.
40.8%	40.5%	345.9	121.3	71.9	42.3%	6/87	86	Redmond, Wash.
24.8%	4.4%	958.1	185.7	139.7	43.6%	6/87	53	Scotts Valley, Calif.
39.6%	43.0%	641.1	115.8	69.9	36.9%	12/87	71	Huntsville, Ala.
38.6%	37.7%	787.9	107.9	18.5	16.2%	2/88	50	New York, N.Y.
41.8%	41.8%	690.0	98.7	57.5	6.2%	3/87	61	New York, N.Y.
31.0%	1.8%	2,079.0	122.4	84.5	14.7%	6/87	30	Melbourne, Fla.
37.2%	43.7%	1,227.2	96.2	60.4	6.6%	12/87	54	Dallas, Texas
32.1%	32.1%	502.0	108.7	73.8	41.5%	4/87	79	Minneapolis, Minn.
44.0%	48.2%	267.3	77.0	43.1	30.3%	1/88	129	Torrance, Calif.
47.5%	43.0%	537.5	69.1	36.3	32.0%	6/87	65	Mountain View, Calif.
56.6%	3.6%	3,366.5	57.4	25.0	20.0%	12/87	26	Minneapolis, Minn.
42.2%	39.7%	386.8	75.8	43.4	68.4%	6/87	90	Lisle, Ill.
30.0%	32.0%	395.6	102.9	72.0	52.3%	12/87	94	Cambridge, Mass.
41.0%	47.0%	493.2	74.8	44.2	45.9%	12/87	82	Sunnyvale, Calif.
45.6%	44.3%	309.3	67.1	36.5	48.7%	3/87	74	Garden City, N.Y.
372.6%	35.4%	1,333.6	6.7	-18.2	46.2%	7/87	46	Norwalk, Conn.
50.0%	-41.0%	495.3	48.5	24.3	15.0%	6/87	81	Atlanta, Ga.
51.1%	43.6%	1,547.1	46.6	22.8	0.0%	6/87	42	New York, N.Y.
48.1%	39.4%	933.4	48.2	25.0	38.0%	12/87	60	Rolling Meadows, Ill.
44.7%	46.0%	174.9	-50.0	-27.6	26.4%	4/87	153	Westwood, Mass.
25.0%	25.0%	960.9	86.4	64.8	48.0%	12/87	58	Natick, Mass.
209.7%	10.8%	1,867.9	-9.3	-28.8	42.1%	5/87	36	Santa Clara, Calif.
35.1%	38.4%	439.1	55.1	35.8	7.0%	12/87	101	Canton, Ohio
36.8%	8.9%	2,836.7	-51.7	70.7	40.1%	6/87	21	Lowell, Mass.

Source: ELECTRONIC BUSINESS

* Net income or loss before extraordinary items and discontinued operations

(Continued)

Taxes paid by top electronics companies

Rank	Company	Total income tax provision (benefit) ($ millions) 1987	1986	Percentage change from 1986	1987 income tax provision (benefit) ($ millions) Federal	State and local	Foreign
46	**Dynatech**	$18.5	$18.5	0.0%	$13.1	$2.0	$3.4
47	**Digital Communications**	17.6	14.0	25.9%	15.6	2.0	0.0
48	**Western Digital**	14.7	7.2	104.4%	6.8	4.0	4.0
49	**Maxtor**	14.6	14.6	0.0%	10.6	3.7	0.3
50	**MAI Basic Four**	14.6	11.3	29.1%	4.5	1.3	8.7
51	**Gerber Scientific**	13.3	13.3	0.0%	11.2	1.5	0.6
52	**Xidex**	12.8	20.2	-36.6%	10.2	2.3	0.4
53	**Apollo Computer**	12.7	6.0	113.8%	4.2	1.9	6.7
54	**Oracle Systems**	12.3	4.6	168.1%	9.1	2.2	0.9
55	**Ultimate**	12.2	12.2	0.0%	9.4	1.8	1.0
56	**Stratus Computer**	12.2	10.0	22.4%	8.1	2.2	1.9
57	**Bolt Beranek and Newman**	11.9	8.4	41.4%	10.9	1.1	NA
58	**Mentor Graphics**	11.4	5.5	105.9%	5.0	0.5	6.0
59	**Wyse Technology**	11.3	7.9	43.5%	9.1	2.1	0.2
60	**Watkins-Johnson**	11.0	12.7	-14.1%	10.9	0.0	0.0
61	**Measurex**	10.7	9.8	9.5%	4.6	0.9	5.2
62	**Mark IV Industries**	10.7	8.4	27.5%	9.6	—[2]	1.1
63	**Varian Associates**	10.5	(25.3)	NM	3.5	1.3	5.7
64	**AVX**	10.5	(1.3)	NM	8.9	0.9	0.6
65	**ADC Telecommunications**	10.2	9.0	13.2%	9.2	1.0	0.0
66	**Emerson Radio**	9.4	9.4	0.0%	5.2	0.7	3.6
67	**Micropolis**	9.1	14.1	-35.8%	(1.3)	3.0	7.5
68	**AST Research**	8.7	22.1	-60.7%	4.7	1.5	2.4
69	**Genicom**	8.6	7.4	16.7%	5.2	1.0	2.4
70	**Avantek**	8.3	13.3	-37.3%	6.8	1.5	0.0
71	**Veeco Instruments**	7.9	0.2	3,282.0%	1.1	(0.3)	7.1
72	**Recognition Equipment**	7.5	6.0	24.8%	2.1	—[2]	5.4
73	**LSI Logic**	7.0	4.1	70.8%	2.3	1.3	3.4
74	**Augat**	7.0	(3.8)	NM	2.9	0.9	3.2
75	**Analog Devices**	6.9	8.7	-20.2%	0.2	0.4	6.3
76	**Inmac**	6.9	4.4	55.4%	3.8	0.8	2.3
77	**Dynascan**	6.6	6.0	10.6%	6.6	0.0	0.0
78	**Altos Computer**	6.1	11.2	-45.5%	4.2	1.4	0.6
79	**Logicon**	6.1	6.1	0.0%	5.1	1.0	0.0
80	**ISC Systems**	6.0	9.9	-39.1%	5.3	0.8	NA
81	**Marshall Industries**	5.9	11.0	-46.8%	4.8	1.1	0.0
82	**Storage Technology**	5.6	17.7	-68.4%	2.7	(0.1)	3.0
83	**Compugraphic**	5.4	1.8	196.2%	NA	NA	NA
84	**Cubic**	5.2	(0.3)	NM	4.1	1.1	0.0
85	**MiniScribe**	5.1	2.8	82.1%	3.0	0.9	1.2
86	**Wyle Laboratories**	4.7	2.7	75.6%	3.8	0.9	0.0
87	**Datapoint**	4.2	8.0	-47.5%	1.3	0.0	2.9
88	**Fluke**	4.2	4.8	-12.4%	3.6	NA	0.5
89	**Anthem Electronics**	4.1	2.9	40.8%	3.3	0.8	0.0
90	**Coherent**	4.1	3.4	19.8%	(0.4)	0.3	4.2

[2] State taxes included with federal

NM = Not meaningful
NA = Not available

Effective tax rate		Fiscal 1987 revenue and income ($ millions)			Foreign revenue as a percentage of total revenue	Fiscal year ended	1987 ELECTRONIC BUSINESS 200 rank	Location
1987	1986	Total revenue	Income before taxes	Net income*				
44.3%	44.3%	$304.7	$41.7	$23.2	25.4%	3/87	102	Burlington, Mass.
39.4%	40.4%	181.4	44.6	27.0	19.0%	6/87	160	Alpharetta, Ga.
25.6%	26.0%	462.5	57.5	42.8	36.9%	6/87	76	Irvine, Calif.
39.4%	39.4%	175.3	36.9	22.4	16.0%	3/87	142	San Jose, Calif.
38.9%	40.0%	321.0	37.4	22.8	64.1%	9/87	106	Tustin, Calif.
38.9%	38.9%	223.9	34.2	21.1	47.0%	4/87	138	Hartford, Conn.
33.5%	38.5%	572.8	38.2	-44.5	29.9%	6/87	85	Sunnyvale, Calif.
37.0%	39.0%	553.7	34.4	21.7	51.8%	12/87	78	Chelmsford, Mass.
44.0%	43.7%	131.3	27.9	15.6	46.8%	5/87	172	Belmont, Calif.
47.0%	47.0%	172.9	26.0	13.8	23.4%	4/87	159	East Hanover, N.J.
38.7%	42.5%	184.2	31.6	19.4	29.2%	12/87	174	Marlboro, Mass.
305.2%	42.7%	233.8	3.9	-8.0	0.0%	6/87	122	Cambridge, Mass.
36.0%	33.5%	221.8	31.7	20.3	45.9%	12/87	151	Beaverton, Ore.
38.5%	38.6%	260.0	29.5	18.1	20.2%	3/87	95	San Jose, Calif.
38.1%	42.5%	264.3	28.7	17.1	19.0%	12/87	133	Palo Alto, Calif.
28.6%	31.7%	227.4	37.5	26.8	59.4%	11/87	149	Cupertino, Calif.
38.6%	45.1%	403.0	27.8	17.0	14.6%	2/88	113	Amherst, N.Y.
33.0%	-63.0%	982.8	31.9	21.4	23.6%	9/87	56	Palo Alto, Calif.
39.9%	-29.2%	271.9	26.3	15.8	43.0%	12/87	123	Great Neck, N.Y.
40.0%	42.9%	166.9	25.4	15.3	12.4%	10/87	178	Minneapolis, Minn.
26.2%	26.2%	810.1	36.1	26.6	0.0%	3/87	63	Secaucus, N.J.
25.0%	43.7%	288.3	36.3	27.2	69.7%	12/87	121	Chatsworth, Calif.
40.0%	44.9%	206.0	21.7	13.0	19.6%	6/87	119	Irvine, Calif.
45.1%	46.2%	302.2	19.2	12.6	32.0%	12/87	116	Waynesboro, Va.
41.8%	45.2%	213.7	19.9	11.6	13.0%	12/87	152	Santa Clara, Calif.
41.9%	13.0%	195.6	18.8	9.2	46.1%	9/87	156	Melville, N.Y.
40.0%	40.0%	264.7	18.7	11.2	49.1%	10/87	126	Irving, Texas
40.7%	48.2%	262.1	17.3	10.7	14.6%	12/87	134	Milpitas, Calif.
37.9%	-30.3%	313.2	18.4	11.5	18.0%	12/87	111	Mansfield, Mass.
27.0%	27.0%	370.4	25.6	18.7	46.4%	10/87	97	Norwood, Mass.
47.0%	46.8%	165.4	14.6	7.7	59.2%	7/87	181	Santa Clara, Calif.
54.4%	49.5%	191.6	12.1	6.6	2.1%	12/87	168	Chicago, Ill.
38.8%	35.7%	153.9	15.8	9.7	42.0%	6/87	188	San Jose, Calif.
50.2%	50.2%	204.8	12.2	6.1	0.0%	3/87	155	Torrance, Calif.
48.0%	41.7%	168.5	12.6	6.5	0.0%	6/87	176	Spokane, Wash.
51.3%	51.2%	286.6	11.4	5.1	0.0%	5/87	105	El Monte, Calif.
22.8%	51.3%	750.0	24.6	19.0	26.4%	12/87	66	Louisville, Colo.
34.8%	35.0%	367.1	15.5	10.1	28.9%	12/87		Wilmington, Mass.
39.8%	-33.5%	361.8	13.2	7.9	0.0%	9/87	114	San Diego, Calif.
15.2%	12.1%	362.5	33.2	28.1	36.1%	12/87	99	Longmont, Colo.
45.0%	38.5%	368.0	10.5	5.8	0.0%	1/88	132	El Segundo, Calif.
7.7%	NM	312.1	-54.3	-58.5	79.2%	7/87	110	San Antonio, Texas
67.5%	28.1%	206.3	6.2	2.0	40.5%	9/87	157	Everett, Wash.
45.2%	52.0%	196.9	9.1	5.0	0.0%	12/87	162	San Jose, Calif.
136.9%	NM	159.0	3.0	-1.1	46.4%	9/87	185	Palo Alto, Calif.

Source: ELECTRONIC BUSINESS

* Net income or loss before extraordinary items and discontinued operations

(Continued)

Taxes paid by top electronics companies

		Total income tax provision (benefit) ($ millions)		Percentage change from 1986	1987 income tax provision (benefit) ($ millions)		
Rank	Company	1987	1996		Federal	State and local	Foreign
91	**Singer**	$4.0	$6.8	-41.2%	$1.3	$0.0	$2.7
92	**SCI Systems**	4.0	8.5	-52.9%	NA	NA	NA
93	**CTS**	3.9	3.5	14.1%	2.4	0.6	1.0
94	**Applied Magnetics**	3.9	0.8	415.3%	2.0	1.1	0.8
95	**Aydin**	3.8	5.2	-27.7%	3.0	0.8	0.0
96	**Micom Systems**	3.7	3.7	0.0%	1.0	1.7	1.1
97	**Intelligent Systems**	3.7	1.5	151.0%	3.0	0.7	0.0
98	**TIE/communications**	3.6	3.1	16.2%	2.7	0.7	0.2
99	**Westmark International**	3.4	(10.9)	NM	2.5	0.7	0.3
100	**Pioneer-Standard**	3.4	1.3	162.1%	2.8	0.6	0.0
101	**DSC Communications**	3.1	2.4	27.9%	0.2	2.6	0.3
102	**Cherry Electrical**	3.0	(1.5)	NM	(0.3)	—[2]	3.3
103	**Tandon**	2.8	2.3	19.1%	2.2	—[2]	0.5
104	**Sprague Technologies**	2.7	1.8	50.0%	0.5	0.2	2.0
105	**Computer Consoles**	2.6	2.0	29.2%	0.2	2.3	0.1
106	**BRIntec**	2.5	6.8	-63.3%	(0.8)	0.2	3.2
107	**Advanced Micro Devices**	2.5	(9.1)	NM	(0.1)	1.6	1.0
108	**Dataproducts**	2.1	2.1	0.0%	0.1	0.7	1.3
109	**Quantum**	2.1	9.6	-78.4%	0.7	1.4	0.0
110	**Paradyne**	1.7	0.8	98.0%	0.0	0.4	1.3
111	**Diasonics**	1.6	1.3	26.2%	0.2	0.1	1.3
112	**VLSI Technology**	1.3	0.3	389.6%	0.2	1.0	0.1
113	**General DataComm**	1.3	(2.4)	NM	0.2	0.3	0.8
114	**Andrew**	1.2	6.8	-82.5%	(2.5)	0.6	3.1
115	**GenRad**	1.1	0.8	43.8%	0.0	0.1	1.0
116	**Oak Industries**	0.8	2.7	-70.6%	0.1	0.1	0.6
117	**LTX**	0.7	(6.2)	NM	0.0	0.0	0.7
118	**International Rectifier**	0.6	0.7	-9.8%	0.0	0.5	0.1
119	**Kollmorgen**	0.6	(2.7)	NM	0.0	0.0	0.6
120	**Sun Electric**	0.5	2.3	-78.2%	(1.2)	0.0	1.7
121	**Savin**	0.3	0.0	NM	NA	NA	NA
122	**Applied Materials**	0.2	0.9	-73.1%	(0.3)	0.3	0.2
123	**Arrow Electronics**	0.0	0.0	0.0%	0.0	0.0	0.0
124	**Esterline**	(2.6)	1.4	NM	(3.3)	0.6	0.1
125	**Cipher Data Products**	(3.5)	3.4	NM	(3.5)	0.2	0.9
126	**Data General**	(4.0)	4.9	NM	(9.1)	(1.0)	6.1
127	**Decision Industries**	(6.0)	3.4	NM	(6.3)	0.2	0.1
128	**Zenith Electronics**	(9.8)	(10.2)	NM	(11.0)	(1.1)	2.3
129	**Teradyne**	(11.7)	(2.9)	NM	(11.5)	(0.3)	0.1
130	**M/A-COM**	(19.6)	(16.5)	NM	NA	NA	NA
	Total	**$8,541.2**	**$6,694.3**	**27.6%**	**$2,649.9**	**$641.1**	**$5,192.3**

[2] State taxes included with federal

NM = Not meaningful
NA = Not available

Effective tax rate 1987	Effective tax rate 1986	Fiscal 1987 revenue and income ($ millions) Total revenue	Income before taxes	Net income*	Foreign revenue as a percentage of total revenue	Fiscal year ended	1987 ELECTRONIC BUSINESS 200 rank	Location
14.6%	10.4%	$1,902.7	$27.4	$23.4	0.0%	12/87	40	Stamford, Conn.
20.0%	38.1%	552.9	20.0	16.0	24.8%	6/87	73	Huntsville, Ala.
27.3%	14.9%	261.1	14.4	10.5	19.7%	12/87	135	Elkhart, Ind.
21.6%	15.6%	211.9	18.1	14.2	46.5%	9/87	144	Goleta, Calif.
30.0%	42.8%	149.2	12.6	8.8	17.8%	12/87	199	Horsham, Pa.
23.3%	23.3%	196.7	15.9	12.2	10.0%	3/87	154	Simi Valley, Calif.
23.6%	61.8%	163.2	15.5	10.2	26.6%	12/87	189	Norcross, Ga.
48.4%	5.6%	250.2	-7.4	-11.1	30.3%	12/87	125	Shelton, Conn.
89.9%	-39.8%	291.9	-3.8	-7.2	28.0%	12/87	118	Seattle, Wash.
39.2%	40.9%	212.2	8.6	1.8	0.0%	3/88	143	Cleveland, Ohio
17.3%	17.8%	312.4	17.6	14.6	14.4%	12/87	112	Plano, Texas
52.6%	-38.8%	160.6	5.8	2.7	49.4%	2/87	190	Waukegan, Ill.
13.9%	3.8%	289.1	19.8	17.1	75.0%	12/87	120	Chatsworth, Calif.
42.9%	1.1%	437.3	6.3	3.6	38.2%	12/87	89	Greenwich, Conn.
21.3%	84.9%	148.4	12.2	9.6	21.4%	12/87	200	Waltham, Mass.
29.8%	36.8%	293.7	8.4	5.9	15.8%	12/87	150	Willimantic, Conn.
5.6%	8.8%	997.1	-45.1	-48.1	27.2%	12/87	57	Sunnyvale, Calif.
19.0%	19.0%	338.8	11.1	9.0	26.8%	3/87	107	Woodland Hills, Calif.
19.0%	30.1%	120.8	10.9	8.8	21.0%	3/87	177	Milpitas, Calif.
176.0%	2.2%	232.6	-0.9	-2.6	17.9%	12/87	146	Largo, Fla.
9.7%	8.0%	267.6	16.9	15.2	3.1%	12/87	127	South San Francisco, Calif.
14.0%	82.7%	172.0	9.4	8.1	22.1%	12/87	184	San Jose, Calif.
62.5%	NM	200.6	2.1	0.8	21.9%	9/87	166	Middlebury, Conn.
23.9%	41.8%	223.2	5.0	3.8	40.7%	9/87	147	Orlando Park, Ill.
34.7%	2.6%	193.8	3.2	2.1	40.4%	12/87	165	Concord, Mass.
12.3%	9.8%	182.2	6.5	5.7	14.4%	12/87	182	Rancho Bernardo, Calif.
11.8%	-32.9%	120.6	-6.0	-6.7	51.0%	7/87	198	Westwood, Mass.
3.6%	60.6%	151.8	-16.6	-17.2	50.1%	6/87	197	Los Angeles, Calif.
67.1%	-11.8%	301.0	0.9	0.3	11.4%	12/87	136	Hartford, Conn.
5.4%	62.4%	203.9	-9.2	3.3	30.0%	10/87	175	Crystal Lake, Ill.
72.8%	0.0%	356.3	0.4	0.1	10.8%	12/87	130	Stamford, Conn.
41.9%	42.0%	174.4	0.6	0.3	43.9%	10/87	158	Santa Clara, Calif.
0.0%	0.0%	562.4	-15.8	-15.8	0.0%	12/87	77	Farmingdale, N.Y.
-8.2%	59.9%	259.7	-31.9	-29.3	39.1%	10/87	167	Darien, Conn.
NM	31.9%	178.2	0.2	4.3	18.4%	6/87	183	San Diego, Calif.
-5.8%	35.0%	1,274.3	-69.9	-82.9	45.0%	9/87	45	Westboro, Mass.
-22.7%	30.7%	191.4	-26.4	-20.4	5.5%	11/87	169	Horsham, Pa.
33.9%	-50.5%	2,362.7	-28.9	-19.1	17.2%	12/87	29	Glenview, Ill.
-35.3%	NM	377.7	-33.2	-21.5	36.4%	12/87	98	Boston, Mass.
-40.1%	-42.6%	436.1	-48.9	-29.3	21.5%	9/87	88	Burlington, Mass.
39.4% Weighted average	**—**	**$202,336.8**	**$21,693.1**	**$13,276.5**				

Source: ELECTRONIC BUSINESS

* Net income or loss before extraordinary items and discontinued operations

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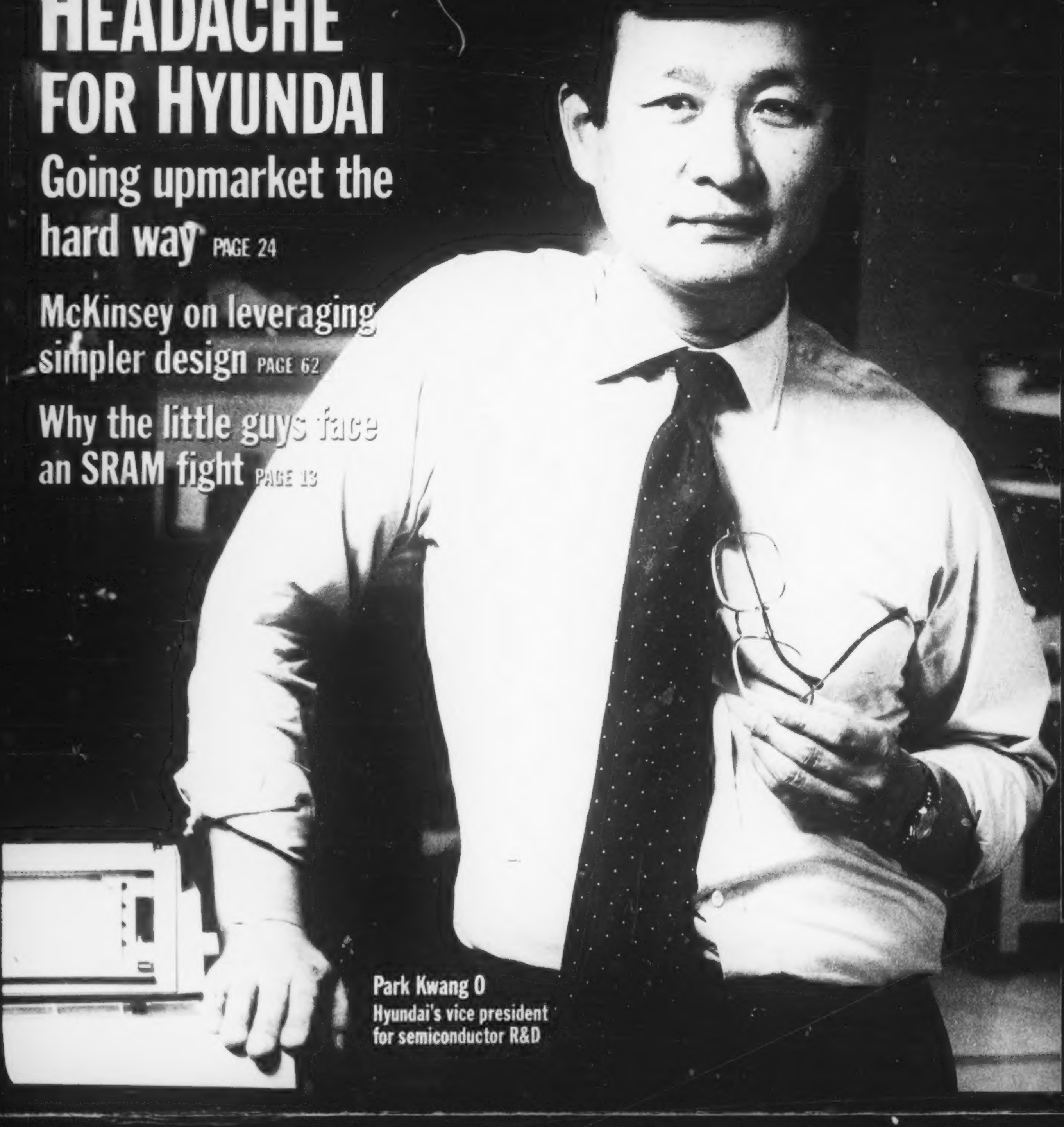

Park Kwang O
Hyundai's vice president for semiconductor R&D

Electronic Business

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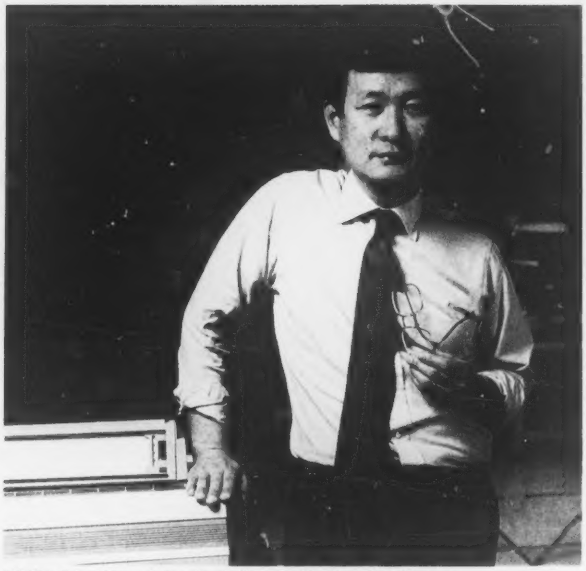
VOL. 15, NO. 3 FEBRUARY 6, 1989



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Six months is enough to obsolete a laptop these days. Pity the vendors as they try to keep up, using everything from upgrades to hiring blitzes.

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NEC has bet on advanced lithium cells for its new laptop, and some board makers are doing the same. But lithium's lead is far from assured.

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Industrial manufacturing continues to pull VME board-level computer growth along. But the low end may be under attack from the ATbus.

86 This is one Force that VME vendors must reckon with

The VME board vendor has tapped a diversified high-end product line to help drive sales of $200,000 per employee.

88 Semiconductor makers bask in the Italian sun

While worldwide chip sales are cooling, they're still hot in Italy. Last year's 50% growth was attributed to the booming domestic high-tech and auto industries.

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Hyundai's dilemma mirrors Korea's dilemma

Hyundai has a problem. After investing $600 million in building its high-technology base largely on the innovation of others, the Korean giant is finding it increasingly difficult to access the same U.S. and Japanese sources of information. Unfortunately for Hyundai, this crunch comes at a time when it needs new technology more than ever. South Korea's low-cost labor and currency advantages are rapidly eroding, making it essential for Hyundai to move upmarket from its commodity products: knock-off personal computers and me-too chips.

So Hyundai has launched a massive effort to become more self reliant. In a way, Hyundai's concerns reflect those of Korea. Both are feverishly trying to move from cheap assembly work to more sophisticated R&D and manufacturing — for their survival. Senior editor Alden Hayashi traveled to Korea to explore these issues. Read his observations in this issue's cover story.

Laptop evolution

Laptop technology is changing fast. Even as industry analysts struggle to define the elements that qualify a computer to be called a laptop, many of those elements are being altered in redesigned products. Indeed, a new laptop can be obsolete within six months. Overwhelmed vendors are fighting hard to keep up, relying heavily on component makers to provide the latest technology.

Assistant editor John McCreadie

Meanwhile, laptop sales are expanding rapidly. U.S. sales tripled in two years to $1.2 billion last year, according to Dataquest Inc. By 1992, worldwide demand could hit $5.9 billion, of which $4.1 billion would be in the United States. So computer and component makers can't afford to be blasé. New ELECTRONIC BUSINESS assistant editor John McCreadie, who joins senior editor Valerie Rice in our San Jose office, takes a look at the opportunities and pitfalls for laptop computer makers in our "Market Perspectives" section.

Another addition to our staff, associate editor Barbara Berkman, explores a related issue: how lithium batteries are rewriting the rules for laptop makers. NEC Corp. is betting big on advanced lithium cells for its new laptop. And some board makers are doing the same. But others wonder if they can achieve the same low-weight payoffs. It's a question that's getting a lot of consideration these days.

BETH KARLIN, managing editor

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BPA ABP

Why Cypress and IDT may have a fight on their hands

The market for sub-35 ns SRAMs should grow 44% yearly to $1.2 billion by late 1993. No wonder TI and Hitachi are interested

These are boom times for high-speed SRAM manufacturers.

With spiraling growth rates, high average selling prices and no dearth of customers, manufacturers of fast static RAMs have the world at their feet right now.

But maybe things are going too well. The high-speed SRAM market has long been dominated by a handful of small American companies (and some Japanese companies), which keep one step ahead of the competition by pushing CMOS technology to its limits. Now, as the slower, commodity SRAM market starts to show some price degradation, large companies on both sides of the Pacific are looking around at new market opportunities and finding fast SRAMs.

Companies including Fujitsu Ltd., Mitsubishi Electric Corp., Motorola Inc., National Semiconductor Corp., Texas Instruments Inc., Toshiba Corp. and others are going after the high end of the SRAM business with big guns, and even some new process technologies like BiCMOS. For the first time, smaller American companies are getting a run for their money.

These companies can "be very responsive," notes William McLean, a market watcher with research firm Integrated Circuit Engineering Inc. "But right now the competition is not all that great. It's going to get tougher."

And not just from U.S. contenders. "I think the American companies are going to be surprised at how aggressively Japanese companies begin to pursue the high-speed SRAM market," says one manager for a Japanese chip supplier. "They've seen price erosion in the commodity SRAM and DRAM marketplace, and they are looking for something to replace those margins."

Margins have been very high in the fast portion of the SRAM market. So high, in fact, that companies such as Cypress Semiconductor Inc. and Integrated Device Technology Inc. (IDT) have had record sales and earnings, in no small way attributable to the success —and high prices — of these chips.

Setting the stage

And those high margins have set the stage for market growth figures little short of phenomenal in the fast (70 nanoseconds and less) and very fast (35 nanoseconds and below) portions of the market.

The total worldwide SRAM market in 1988 hit $1.7 billion, says Dataquest Inc., and should grow to $2.8 billion by 1992. But those figures mask the real areas of growth — and megabucks opportunity — to be found in the fast and very fast portion of the static RAM marketplace.

Market research firm ICE says the market for very fast SRAMs in 1988 was $420 million, but is expected to grow at a 44% compound annual growth rate over the next five years, hitting $1.2 billion by the end of 1993.

Fueling the growth in this market segment are two very unrelated occurrences: the shortage of 1-megabit DRAMs and the advent of 32-bit high-performance microprocessors.

For some two years now, the 1Mb DRAM shortage has drawn management attention and dollars away from SRAMs. This has caused a shortage of commodity SRAMs in some areas, according to analysts, because fab lines have been dedicated to intensive DRAM production. The SRAM market is also only one-third the size of the DRAM market, according to ICE, making it inherently less visible to management.

But now that the DRAM crunch is easing, the SRAM market numbers

Cypress' SRAM marketing manager Tom North: "The most significant change in the SRAM market today is that there is a market now in PCs and workstations"

Liane Enkelis

are looking very appealing. And large companies are rising to the bait.

Another thing tempting large companies is volume. This volume is in both personal computers and workstations, two very large market segments that have been historically out of reach of the average SRAM maker.

Thanks to hot new microprocessors that demand fast cache memories, SRAMs have found a niche —a big niche — in workstations and high-end personal computers. And that niche will spell m-o-n-e-y in the future.

Of the $420 million sold in very fast SRAMs in 1988, $95 million, or almost 25%, went into workstations; $85 million into supercomputers; $75 million into high-speed instrumentation; $100 million into the military; with the remainder going into an "other" category, which includes telecommunications and personal computers, according to ICE.

Workstations are big drivers in this market today, and small American companies, as well as large ones, are going to go aggressively after this market share.

"The most significant change in the SRAM market today is that there is a market now in PCs and workstations," says Cypress' SRAM marketing manager Tom North. But North cautions that the "PC business is a two-edged sword," and notes that Cypress has no more than 10% of its business in the PC arena right now.

Cypress' acknowledged main competitor, IDT, also has a strong concentration in the PC arena, according to Robert Cushman, SRAM business unit manager.

Both North and Cushman agree that the biggest challenge facing them is keeping ahead in the new product wars. One solution both companies appear to have adopted is the so-called "specialty memories," or SRAMs which are closely coupled to a particular computer architecture.

"Today there has to be a closer relationship between processor and memory makers," Cushman states categorically. IDT has announced an SRAM designed to work specifically with the MIPS Computer Systems Inc. 3000 RISC chip. Cypress has announced plans for both an Intel Corp. 80386 SRAM, as well as a Sun Microsystems Inc. Sparc SRAM.

SRAMs have found a big niche in workstations and high-end PCs

Even Japanese giant Hitachi Ltd. has plans to roll out some SRAMs which will be tailored to specific microprocessors, says Ron Bechtold, product marketing engineer. The memories will likely be targeted at the 80386 and Sparc chips.

"There is definitely a trend to unique 32-bit architectures," according to Bechtold. Vendors need "to look at cost sensitive, customized architectures for specific niches."

The other major challenge to the dominance of small American companies is BiCMOS — a relatively new process that combines the speed of bipolar with the low power and temperature qualities of CMOS. Companies such as Hitachi, Saratoga Semiconductor, National Semiconductor and others are making a major push into the BiCMOS SRAM area, hoping that the hybrid process will have the right stuff for a number of users.

Currently, the market for BiCMOS high-speed SRAMs is relatively small, only 3% to 4% of the $420 million total market, according to ICE. But that number is expected to increase at a compound annual growth rate of 33% over the next five years, growing from $40 million in 1988 to $400 million in 1993.

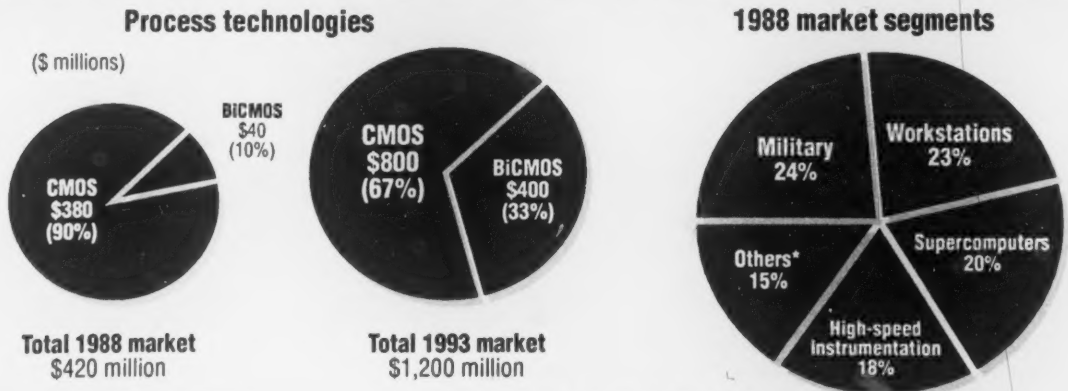
At Hitachi, which has been a big BiCMOS player since the beginning, that figure comes as no surprise. Although Hitachi has a large CMOS SRAM presence as well, it is betting that the BiCMOS product will continue to grow strongly into the 1990s, Bechtold says.

"With BiCMOS, you can get the next generation speed at the current generation price," he says. "It allows an SRAM manufacturer a higher speed part sooner."

But BiCMOS will unlikely displace CMOS over the next five years, analysts agree, noting that at least at the high submicron level (0.8 micron and up), CMOS is still highly competitive.

VALERIE RICE

High-speed SRAMs: Process technologies and market segments



Source: Integrated Circuit Engineering Corp.

* Includes telecommunications and PCs

The Korean conglomerate has not done in chips and PCs what it has done in subcompact cars — and it charges that U.S. and Japanese firms may not let it. Can Hyundai go it alone as its technology sources dry up?

Hyundai's headache

BY ALDEN M. HAYASHI

Hyundai's vice president in charge of semiconductor R&D, Park Kwang O: "The U.S. and Japan want to stomp us out"

Ray Cranbourne/Black Star

Call it your basic "stuck between a rock and a hard place" bind, Korean style.

First, the "rock." The Hyundai Group, one of South Korea's four *chaebol*, or industrial conglomerates, has so far gambled more than $600 million in the global high-tech market. After a slow start, the company finally looked as if it had made some progress last year when officials were expecting meager profits after losing money for the past five years.

But Hyundai, which has forged alliances with American giants such as Texas Instruments Inc., barely has time to celebrate. Company executives — who acknowledge that South Korea's low-cost labor and currency advantages are rapidly eroding vis à vis the country's Asian neighbors — cite the need to move quickly upmarket from Hyundai's bread-and-butter base in commodity products: knock-off PCs and me-too chips. But that trek upmarket will only be possible through continued access to state-of-the-art technology.

Which brings us to the "hard place." Just as Hyundai achieves electronics prominence based on the innovation of others, U.S. and Japanese competitors are beginning to block the flow of technology to the Korean company. Already, Intel Corp. has engaged the Korean conglomerate in a nasty lawsuit charging alleged intellectual property infringements.

Squeezed on both fronts, Hyundai is trying to develop its own technology by pumping up R&D budgets. Engineering staffs have increased dramatically and a new multimillion dollar semiconductor lab is under construction. Hyundai has also entered into various research consortiums as the company scrambles to sign technology-exchange agreements in the sectors it has chosen to compete in: ICs, personal computers, minicomputers, peripherals and telecommunications equipment. And the shipbuilder, automaker and construction-engineering supremo has declared as its goal membership in the world's top 10 chip makers' club. But whether this flurry of activity helps Hyundai achieve in electronics what it has excelled at in cars is still in question.

The $600 million high-tech dilemma reflects concerns not only at Hyundai but at sister *chaebol* like Samsung and Lucky Goldstar, despite their strong track records in consumer electronics. Indeed, it has broad implications for aspiring electronics powerhouses throughout the Far East. However, as Hyundai prepares to take a tougher line in dealmaking, its problems prompt the need for a reexamination by United States and Japanese electronics companies of the nature of their joint ventures with other Far East partners.

One thing's for sure: Hyundai sorely wants a place in the global electronics limelight. Just five years ago, the $18 billion multinational corporation — faced with a decline in its mainstay shipbuilding and construction businesses — decided to gamble on the fast-growing electronics market. The ante, apparently, was no object. In semiconductors alone, the company spent $345 million on a pair of fabs. A new $350 million manufacturing facility, including an R&D lab, is currently under construction.

Hyundai's electronics gamble — culminating in the creation of Hyundai Electronics Industries Company Ltd. in 1983 — was particularly risky at the time because, prior to then, the company knew virtually nothing about high tech. In contrast, Korea's Samsung Electronics and Lucky Goldstar both had consumer electronics experience before their forays into the semiconductor and computer markets. Still, Hyundai's come-from-nowhere success in automobiles should make competitors think twice before discounting the company's high-tech aspirations.

After a sluggish start in personal computers and a near disastrous one in chips, Hyundai finally looked like it had a winning hand last year. If all goes well as the final numbers are tallied, the company will have made $10 million on high-tech sales of roughly $700 million, according to a company forecast. The year before, Hyundai Electronics lost $12 million on sales of $320 million.

In semiconductors, the company's sales should top $400 million this year, up from about $250 million in 1988, according to Park Kwang O, Hyundai's vice president in charge of semiconductor R&D. And the company this year should export $1 billion of electronics products. In 1988, Hyundai was the 10th largest vendor of low-end PCs in the United States. The company that year sold 62,400 such machines based on Intel's 8086/88 microprocessors.

Hyundai execs always ask why Korea is being forced to pay for Japan's past sins

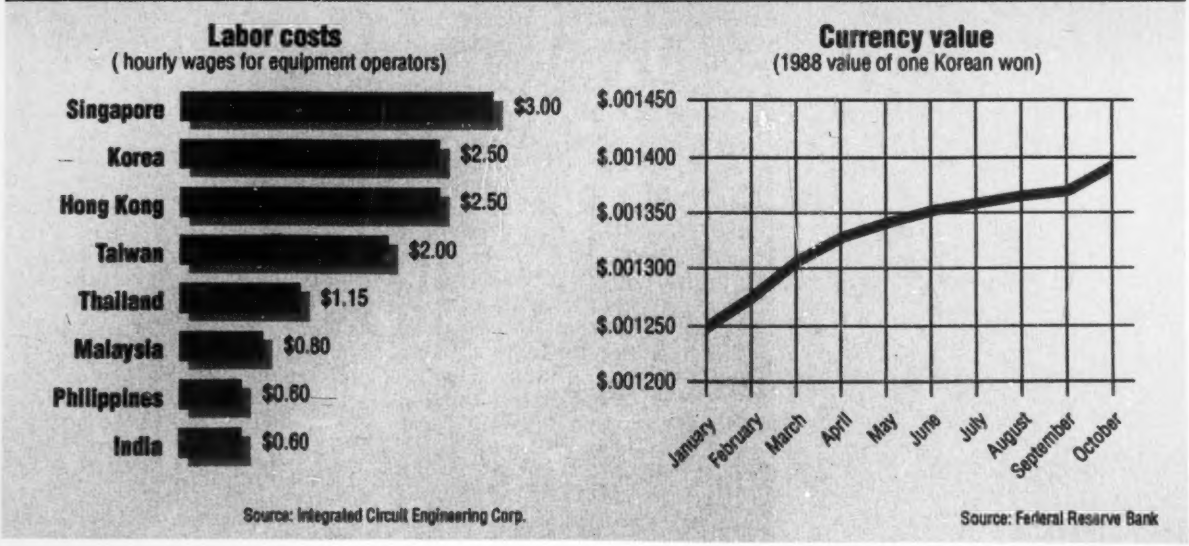
If Hyundai Electronics stays on track, officials say the 11,000-employee subsidiary will go public in 1992. (Currently, the entire Hyundai Group is privately held, but the conglomerate has plans to make public many of its subsidiaries over the next several years.)

The success of Hyundai Electronics, however, has so far been a result of the company's low-cost labor and currency advantages. In the semiconductor field, half the company's business is foundry work for others. In computers, Hyundai makes PC clones and peripherals such as monitors, printers and modems for OEM companies like Commodore Business Machines Inc., Digital Equipment Corp., IBM and Xerox Corp. Hyundai also makes Big Blue PCs for the Korean market.

In a simplified way, Hyundai is a microcosm of Korea. Both company and country are feverishly trying to lessen their dependence on sunset industries in favor of sunrise ones. During an hour-long interview, Choo Hoon, the executive vice president of Hyundai Electronics' information systems division, presented a tidy summary of Korea's predicament. From memory, he recited some daunting statistics: Thailand has a population 20% greater than that of South Korea. Also, Thailand's land mass is five times larger. And, perhaps most importantly, labor costs there are a fraction of Korea's. Furthermore, for the People's Republic of China, the figures are even more skewed against Korea, says Choo.

Recent events have only made the situation worse. Throughout last year, the Korean won appreciated at a frightening rate. From January to

South Korea is losing its low-cost labor and currency advantages



Labor costs
(hourly wages for equipment operators)

Source: Integrated Circuit Engineering Corp.

Currency value
(1988 value of one Korean won)

Source: Federal Reserve Bank

October, the currency had risen by more than 10%, making manufacturing costs that much higher in the country. Consequently, Choo concludes, "If we continue to do just assembly work, we cannot survive." Executives at Samsung and Lucky Goldstar are reportedly worried about precisely the same issues.

The kindness of strangers

It would be an understatement to say that Hyundai's progress in electronics has depended upon the kindness of strangers. The company's personal computers are IBM clones. The architecture and software of its 32-bit minicomputers come from Tolerant Systems Inc. of San Jose, the floppy disk drive technology from Fujitsu Ltd. and printer know-how from Canon Inc.

In semiconductors, the company bought electrically erasable programmable logic device (EEPLD) technology from a company it helped finance: International CMOS Technology Inc. (ICT) of San Jose. SRAM designs are from MOS Electronics Corp. (Mosel), also of San Jose; ASIC design software from LSI Logic Corp. of Milpitas, Calif; and Hyundai's DRAMs are thanks to, not one, but three companies: Inmos Corp., Texas Instruments Inc. and Vitelic Corp.

A lesson in patience

Hyundai's history in DRAMs could well serve the company as a valuable lesson in patience. Several years ago, Hyundai had hoped to learn the fundamentals of DRAM manufacturing from Inmos, but the agreement subsequently crumbled before production had even started. Both companies later reached an out-of-court settlement whose details have remained private.

In ICs alone, Hyundai increased its R&D staff from 160 in 1987 to 250 last year

However, a contract with Vitelic followed in 1985 but the project reportedly fell a year behind schedule because of Hyundai's inexperience. At the time, Vitelic president Alex Au quoted: "The manufacturing problems are tremendous."

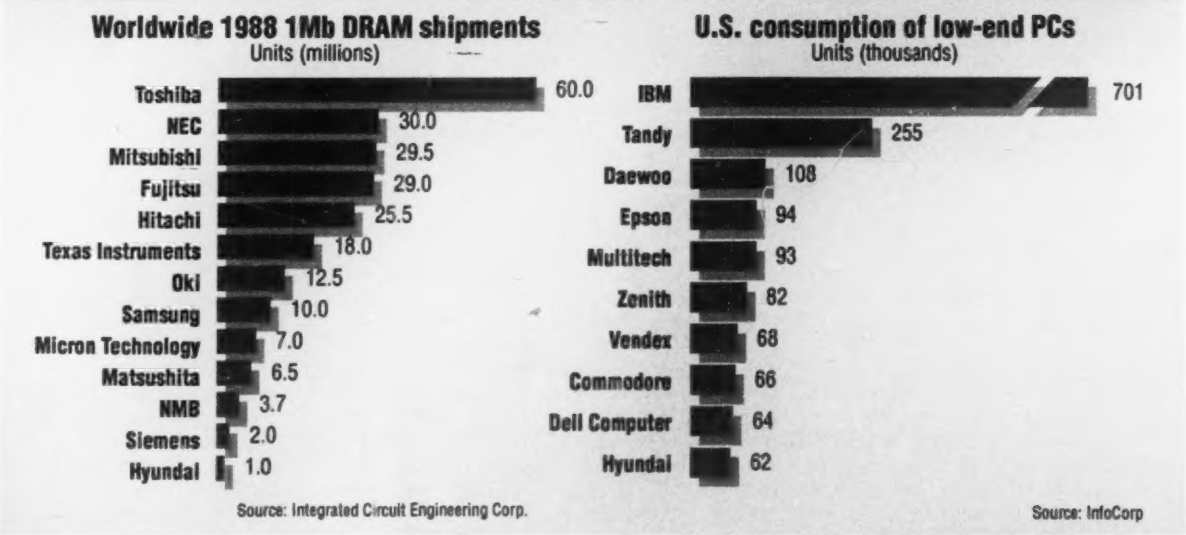
Actually, it took a team of TI engineers most of 1987 to get Hyundai's manufacturing up to snuff. In exchange for the private tutoring, Hyundai has supplied Texas Instruments with foundry services. "With Hyundai's new fab, they should be very competitive with the Japanese," according to Bruce Campbell, vice president of marketing for Mosel, which also subcontracts out its manufacturing to the Korean company.

Clearly, the TI relationship has benefited Hyundai and Park says he is intent on maintaining the partnership. But whether the feeling is mutual is entirely a different story. Indeed, TI appears to harbor no particular feelings of loyalty toward its Korean comrade, especially given Hyundai's recent emergence as a semiconductor competitor. In the past, more than 80% of Hyundai's total production used to be foundry work as the company learned from others the ins and outs of semiconductor manufacturing. But Hyundai has not been content just making chips for others to sell. Park makes no bones about his all-consuming goal: make it onto the list of top 10 worldwide semiconductor companies within a decade. Consequently, Hyundai's foundry work has fallen to 50% of production, and Park says his goal is to have the figure drop further, to below the 30% mark.

Such brashness from the new kid in town worries TI chairman Jerry Junkins. When asked who TI would license its next-generation DRAM technology to, Junkins was unusually curt. "It may, or may not, be Hyundai," he replied.

At any rate, Junkins says his strategy is to stay one technological step ahead of the foundries. To that end, Junkins says TI will only license its

Hyundai can't count itself in the big chip and PC leagues yet



Source: Integrated Circuit Engineering Corp.

Source: InfoCorp

"If we continue to do just assembly work, we cannot survive," says Choo Hoon, executive vice president of Hyundai Electronics' information-systems division

Ray Cranbourne/Black Star

1-megabit design when the company is more than ready to move on to the 4Mb DRAM level. Hyundai is currently making TI's 256-kilobit DRAMs.

Junkins' strategy is shared by others. Hyundai's Choo complains, "Canon let us have their impact printer technology only after they had moved to laser technology. I tried several times to get Canon's laser printer technology, but in all cases, they denied it."

Other sources of technology may also be drying up. Five years ago, Hyundai invested in ICT, a San Jose chip start-up. Eventually, the Korean company received ICT's EEPLD design in a cash-for-technology deal. Today, Hyundai retains just a minority stake in the firm and ICT president and founder Drew Osterman says he does not expect any further technology exchanges between the two companies.

A spat with Intel

Indeed, the mood in the United States has taken a sharp turn away from the laissez-faire atmosphere of the past. Last November, a judge for the International Trade Commission ruled against Hyundai in a patent spat involving Intel's EPROM technology. If Intel's patent infringement claims are upheld, the offending Hyundai chips could be barred from entry into the United States.

And companies are demanding more for sharing their intellectual property. Although Hyundai freely knocked off IBM's personal computers in the past, Choo says that Big Blue has become extremely protective regarding its new generation of Personal System/2 PCs. "We're talking with IBM but nobody knows what will happen. They're asking too much for patent royalties," he asserts.

Hyundai officials have noticed the mood swing in the United States. Two years ago, Park brushed off the growing number of intellectual property lawsuits as a "Mickey Mouse game." Recently, he acknowledged that continued access to technology has become one of Hyundai's most critical problems.

In many respects, the United States' tough stance puzzles the Koreans. Hyundai executives repeatedly question why Korea is being forced to pay for Japan's past sins. It is this feeling of persecution coupled with the company's severe dependence on foreign technology that has top management teetering on the verge of paranoia. "The U.S. and Japan want to stomp us out," cries Park. "There's no way we can survive being dependent on outside technology."

So, Hyundai is doing the logical thing: trying to develop the necessary technology in house. The company spent roughly 25% of its $250 million in semiconductor sales on R&D last year, according to Park. "You have to spend money to make money," he says.

And spend money Hyundai has. For semiconductors alone, the company increased its R&D staff to 250 people last year from 160 people in 1987. This year, Park plans to increase the number to 400. Hyundai will need the additional personnel for the company's new $350 million fab, scheduled for completion during the third quarter this year. In the fab, one of the 6-inch wafer lines will be reserved for production, the other for R&D. The fab's production capacity, when fully operational, will be 40,000 6-inch wafers a month.

In computers, the story's the same. "My president ordered me to not increase our direct labor. But there are no limitations placed on R&D labor," says Choo. In his division, R&D personnel will surge from 200 people last year to roughly 300 this year. The company is particularly keen on software development; roughly 30% of its R&D staff were software engineers last year.

Almost to the point of desperation, Hyundai has been trying nearly everything to stoke the company's technological creativity. Three engineers whose IQs each exceeded 150 were hired from the Korean Advanced Institute for Science and Technology. The engineers were placed in a think tank and management has given them total freedom. "They get to work on whatever they want. I think one is working on image processing," says Choo.

However, some progress has been made. Hyundai says the 1Mb DRAM scheduled for production in its new fab is its own design based on Vitelic's technology. At the same time, the next-generation 4Mb DRAM, which Hyundai plans to offer engineering samples of later this year, will also be the company's own design, according to what Park claims. And Hyundai expects to be among the first to develop a 16Mb DRAM by 1992. "From older technologies we can develop some very innovative products," according to Choo.

Can Hyundai do high-tech R&D? The evidence to date has not been encouraging. After opening a large semiconductor R&D center and wafer fab in Santa Clara in 1984, the company abruptly closed shop there a year later. The building and land were sold to Siemens; the equipment and a handful of the personnel were moved to Ichon; and the company took an estimated $20 million loss. Hyundai's mistake was in investing too much too soon, says Park. "Upper management got impatient when the output for the facility was not immediately proportional to the input."

One thing that the California R&D center would have provided Hyundai with is engineering talent. Silicon Valley is littered with experienced electrical engineers; Seoul is not. To broaden its pickings, Hyundai revised its policy in Korea of only hiring Korean nationals. Still, Park admits that although Hyundai has been trying to attract qualified engineers from the United States, few have wanted to make the move to the company's industrial park in Ichon, a farming village about an hour's drive from Seoul.

Hyundai's shortage of technical brainpower is compounded by the company's lack of experience. "Many of our semiconductor people have Ph.D.s, but not one of them can design a simple circuit," laments Choo. "All we can do is take somebody else's mask set and produce the chip." Park acknowledges that the average age of his engineers is below 30. "But," he adds, "they work twice as hard as other engineers."

Hyundai expects to be among the first to develop a 16Mb DRAM by 1992

Even *with* the appropriate personnel, Hyundai's midstream efforts might still land the company in court. Analysts claim the company may have just too much catching up to do. "They're going to find it very difficult to develop their own technology at this level without stepping on somebody's toes," notes William J. McClean, analyst for market researcher Integrated Circuit Engineering Corp. of Scottsdale, Ariz.

Where possible, Hyundai is borrowing any outside technology which is readily accessible. In the information processing arena, it should come as no surprise that the company settled on Unix, which AT&T licenses for a nominal fee, as the operating system for its superminicomputers. By doing so, Hyundai is hoping to tap into the vast public library of Unix software. And, according to Choo, the company may join the so-called "Gang of Nine," the group of nine computer manufacturers — including Compaq Computer Corp., Tandy Corp. and Zenith Data Systems Corp. — whose charter is the development of a PC bus alternative to IBM's closely guarded Micro Channel technology.

In addition, the Koreans have adopted a "united we stand" strategy. A group of companies, including

Semiconductor technology alliances held by Hyundai electronics

Companies in alliance (technology)

Texas Instruments Japan (256K DRAMs)
TI to technically assist Hyundai's mass production of 256K DRAMs. Hyundai will then sell DRAMs to TI on an OEM basis. **Date announced:** July 1988.

Daewoo, Korea Electronics and Samsung (32-bit ICs)
Joint R&D program to develop 32-bit PC microprocessors and microcontrollers through December 1990. **Date announced:** 1988.

Korea Electronics and Samsung (transistors)
Joint R&D program to develop high-power transistors through December 1990. **Date announced:** 1988.

Intel (EPROM and DRAM patents)
Intel charges Hyundai and U.S. subsidiary with EPROM and DRAM patent infringement. **Date announced:** September 1987.

Mosel (CMOS products)
Hyundai to act as a foundry for Mosel's CMOS products. **Date announced:** February 1986.

Electronics Technology Research Institute, Goldstar and Samsung (Submicron processes)
Joint R&D program to develop submicron technology processes and products. **Date announced:** 1986.

Inmos (256K DRAMs)
Joint development of 256K DRAMs from Inmos technology and alternate sourcing agreement. **Date announced:** February 1985.

Ricoh (Silicon wafers)
Ricoh to supply foundry services to Hyundai. **Date announced:** 1985.

Vitelic (DRAMs, SRAMs in CMOS)
Exchange of Vitelic's technology for Hyundai's foundry. **Date announced:** 1985.

Inmos (CMOS memories)
Date announced: 1984.

Western Design Center (CMOS microprocessors)
Hyundai to make and market WDC's 8-bit and 16-bit CMOS versions of 6502 microprocessor. **Date announced:** 1984.

International CMOS Technology (CMOS EEPROMs)
Joint development and marketing of 1K CMOS EEPROM. The firms to develop three other chips each that both will market. Hyundai to provide foundry services. Hyundai has an equity investment in ICT. **Date announced:** 1983.

Source: Regis McKenna Inc.

Hyundai, have banded together to develop high-density memory chips. Hyundai is also involved with some of the other Korean *chaebol* in another project to develop a parallel processing superminicomputer using the Unix operating system.

So far, the memory chip consortium has been a success, claims J.H. Son, manager of the Seoul office of market researcher Dataquest Inc. According to Son, the group has already developed a manufacturable 4Mb DRAM. Another $263 million has been allocated to develop a 16Mb DRAM by March 1991 and a 64Mb DRAM two years later. Sixty percent of the funding comes from Daewoo, Goldstar, Hyundai and Samsung, with the remainder financed by the government.

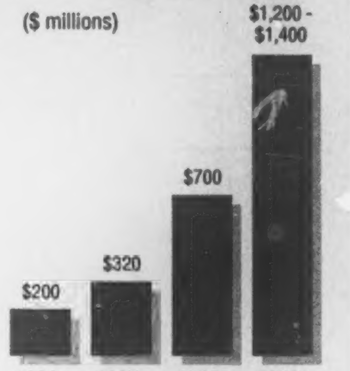
Hyundai, however, has not given up on partnerships with foreigners. The company was recently negotiating with Seagate Technology, the ailing disk drive king of Scotts Valley, Calif. A joint venture between the two companies might make sense; at one point last year, Hyundai was buying 7,000 hard disk drives a month from Seagate. Previously, the Korean company was able to obtain floppy disk drive technology from Fujitsu.

Hyundai is also counting on global partnerships to diversify its semiconductor business. DRAMs currently make up roughly 70% of Hyundai's total chip sales. Last year, the company sold more than $180 million of DRAMs, accounting for approximately 3.5% of the total worldwide market. Park, who compares Hyundai's semiconductor division to a table with uneven legs, says the company needs to get quickly into other markets such as logic chips and ASICs. Indeed, the next DRAM industry downturn — which might occur as soon as late this year — could propel Hyundai's DRAM business back into the black, says Dataquest's Son.

In order to branch out, Hyundai will have to enter into several winning partnerships. But the company is tired of playing the role of the needy relative seeking a handout. In the future, Hyundai will only enter into mutually dependent partnerships as opposed to cash-for-technology deals, according to what Park says. That way, Hyundai will be less vulnerable to being jilted, he asserts.

In its semiconductor hope chest, Hyundai boasts three belongings: a somewhat mature manufacturing process, a budding memory chip business and lots of cash. Such a dowry might interest a European suitor like N.V. Philips or SGS-Thomson, speculates ICE's McClean. Also, a company like National Semiconductor Corp. could use Hyundai to springboard back into the DRAM business.

Hyundai's electronics sales



* Estimates

Source: Hyundai

One thing Hyundai will not do to solve its technology woes is buy another company, states Park. In spite of the current spate of hostile takeover attempts in the U.S. electronics industry, Park contends such actions court disaster. There exists no guarantee, he says, that a high-tech company's greatest asset — its engineers — would remain after being acquired. "We don't want to end up holding an empty bag."

It's an understatement to say that Hyundai's progress in electronics has depended upon the kindness of strangers

Beg, borrow or . . .

Ultimately, Hyundai's success in the electronics market will depend on how well the company can beg, borrow, or — the gods of high-tech permitting — invent by itself the necessary technology. One thing's for sure: such knowledge does not come cheap — not anymore.

Whether Hyundai's corporate elite fully realize this is unknown. In fact, the company's detractors claim Hyundai's top brass still lack a complete understanding of the electronics industry. Critics claim Hyundai's founder and chairman Chung Ju Yung oversees the conglomerate's 25 subsidiaries like a feudal lord guarding his fiefdoms. In charge of Hyundai Electronics is Chung Mong Hun, Chung Ju Yung's son. Before assuming the top post at Hyundai Electronics, the then 35-year-old Chung had virtually no experience in high tech.

On their part, Hyundai officials do not see their electronics foray as particularly risky. In fact, they say they are willing to do whatever it takes to succeed. To that end, the company recently announced it would invest an additional $1.15 billion in electronics during the next five years. As the anecdote goes, when one executive was asked why Hyundai was gambling so much in an unfamiliar market, he replied, "We don't think it's risky. After all, we do construction in the Middle East."

Nonetheless, Hyundai's long-term commitment to the electronics market remains suspect. Lodged in many people's minds are memories of the company's abrupt pullout of Santa Clara. According to one report, Hyundai workers there arrived at work one day to find the gates locked and a notice that final paychecks were in the mail. Not surprisingly, many former employees and a few current ones have repeatedly complained of the impatience of Hyundai's top management. "There's a lot of resentment in the company about that," notes George Long, research analyst with investment brokerage W.I. Carr Ltd.'s Seoul office.

As the company's high-tech investments tally toward the $1 billion mark, Hyundai's employees — particularly chairman Chung Ju Yung — must be wondering just how long and how much money it takes to play the high-tech game. The answer may be supplied by the Goldstar Co., which last September announced plans to build a new semiconductor fab in Chongju, Korea. The facility's completion date: 1996. Its price tag: $2.22 billion. □

Does military R&D stimulate commerce or the pork barrel?

Pentagon officials insist massive defense spending has a hidden reward — lucrative and numerous commercial spin-offs. Others aren't so sure

BY MICHAEL R. LEIBOWITZ

Commercial spin-offs. They're mysterious and fuzzy and defy all attempts at measurement. And their vagueness makes them the ideal riposte for policy debates. The Pentagon cites potential spin-offs to justify expensive military programs. Legislators use the specter of spin-offs to argue that the U.S. doesn't need to fund efforts like Japan's MITI. Even the Japanese talk of our spin-offs to claim that the U.S., in fact, also provides substantial government support to its electronics and computer industries.

Those who use the spin-off argument cite history. They recall that the U.S. Department of Defense was the prime support of such technologies as computers and transistors in the 1950s, integrated circuits in the 1960s, and networking in the 1970s. Commercial spin-offs, proponents argue, are the hidden reward for spending massive sums on defense R&D.

Using this argument, the 1980s should be the golden age of military-inspired electronics and computer spin-offs. Since the defense buildup began in 1982, a record of more than $12 billion has been spent on electronics-related R&D for programs ranging from very high-speed integrated circuits (VHSIC) to the Strategic Defense Initiative.

But, many are now asking, where are the spin-offs? "In general, they have declined," says Kenneth Flamm, an economist at the Brookings Institution, a nonprofit Washington research group. Flamm, along with a growing number of critics, contends that the notion of lucrative commercial outgrowth of the 1980s defense R&D buildup is little more than a myth.

For example, when the three current VHSIC Phase II contractors — Honeywell Inc., IBM and TRW Inc. — were asked about commercial spin-offs, none could come up with anything significant. Robert Estrada, manager of IBM's VHSIC program in Manassas, Va., says that while senior executives view the program as being important, "there might be some disagreement with the commercial side as to how much they've benefitted." The $1 billion, 10-year effort is aimed at achieving 0.5-micron radiation hardened ICs.

Pork barrel

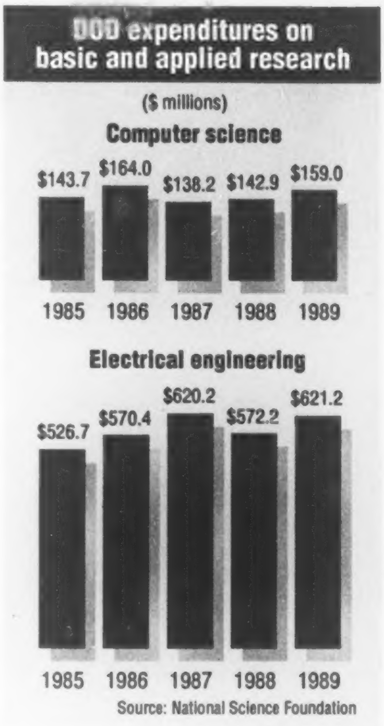
Gordon Bell, R&D vice president at Ardent Computer Corp. and father of the minicomputer, puts his opinion about VHSIC a bit stronger: "[VHSIC's purpose] was to bring a bunch of old-line, miserable semiconductor guys up to the state of the art of commercial. It's a big pork barrel business." Agrees Brookings' Flamm: "It's been the antithesis of how to run a program to get spin-offs."

Flamm and others point to several key policy changes that have helped stifle commercial spin-offs in the 1980s. Prominent among these is a shift away from basic research toward development of specific military technologies — technologies that are expensive and have little in common with the needs of the commercial marketplace. Funding has also shifted from universities to defense contractors, where the ideas get trapped with no way of reaching the commercial market.

Even the Defense Advanced Re-

Ardent Computer's Gordon Bell, father of the minicomputer, calls VHSIC "a big pork barrel business"

Cindy Charles


DOD expenditures on basic and applied research

Source: National Science Foundation

search Projects Agency (DARPA), the arm of the Defense Department widely credited as contributing the most to the commercial base during the past 25 years, has seen its research agenda politicized in the 1980s, critics charge. This means less return from projects such as DARPA's Strategic Computing Program, the $600 million effort designed to promote the most promising computing technologies.

The diminishing payout in commercial spin-offs comes as a surprise to anyone familiar with Defense's history as a booster to the civilian computer and electronics industries. Since the dawn of the computer age, Defense has played the role as key funder and early patron of electronics' most important new technologies.

Birth of the computer

Who would pay money for a computer that had 18,000 vacuum tubes and failed once a day on average? Only the military. Defense paid for development of the ENIAC and provided a market for many of the computers developed in the 1940s and early 1950s. It wasn't until the late 1950s that a significant commercial market for these machines developed.

Likewise, the military and NASA snatched up the first crude integrated circuits at $100 a pop in the early 1960s, when no one else would. DARPA paid for the world's first packet switching network in the 1970s, advancing a technology that has become the staple of datacommunications.

This decade's spin-off examples include expert systems, which derived from rule-base programming work sponsored by DARPA in the late 1970s. And you can thank DARPA for Unix-based workstations, as well. Sun Microsystems Inc.'s first Unix-based technical workstations in 1982 spun from a DARPA-sponosored program at Stanford University and Berkeley 4.2 developed at the University of California at Berkeley.

"The field of computer science, pure and simple, was invented and fueled by DARPA," says Dan Dimancescu, technology policy consultant and author of several books on R&D policy. But several changes have occurred since 1982 to limit the potential for commercial spin-offs from defense R&D. Perhaps the most dramatic, according to economist Flamm, is the fact that almost none of the new funds spent on military R&D have gone to research. Virtually all have gone to develop specific military applications, dominated, of course, by SDI. Military expenditure for basic research, says Flamm, "has, in fact, declined somewhat from its 1970s levels."

The short shrift that research has gotten is significant because, dollar for dollar, research is generally considered to be a far more fruitful source of spin-offs. Military development concentrates on accomplishing specialized engineering feats — exotic advances that have little usefulness in the commercial market. Yet, research focuses on making progress in fundamental, generic technologies that can also solve problems in the commercial market.

Most of those commercial spin-offs cited earlier resulted from research funding. Occasionally however, development funding does benefit the commercial market by providing an early market for an emerging technology.

The VHSIC scenario is different, however. One of the reasons for the dearth of VHSIC spin-offs is the program's goal of radiation-hardness, which isn't an important consideration in most nondefense applications. Another problem is that, for the military, cost is no object. Instead of trying to refine optical lithographic techniques to acheive the 0.5-micron device geometries, for example, contractors are "brute forcing" it with expensive E-beam and X-ray lithography. The task of pushing less-expensive optical lithography — into the submicron range is left to the commercial chip makers.

With the shift from research to development has come a corresponding shift from an emphasis on university laboratory work to an emphasis on large defense contractors. And with this comes secrecy, the bane of any attempts to commercially transfer technology. "To get broad utilization of R&D, it has to be published," says Robert Noyce, coinventor of the integrated circuit and chief executive of the Sematech semiconductor consortium. Today, he says, "less and less [VHSIC and other military R&D] is."

With research held captive inside the contractor's walls, one hope is that the defense contractor itself might try to commercialize the technology. Yet, many of the defense contractors, companies such as General Dynamics Corp. and Martin Marietta Corp., lack the commercial divisions that could bring the spin-off to market.

And in the cases where research information is published by the defense contractors, the details are kept under wraps, according to Lou Thomasetta, CEO of gallium-arsenide chip maker Vitesse Semiconductor Corp., in Camarillo, Calif.

Even if a company has a commercial side to it, the chances for spin-offs are slim, according to Kent Black, president of Rockwell International's electronics operation. Although Rockwell has a large commercial operation, accounting for 40% of its electronics revenue, transferring technology between military and commercial is "very difficult," says Black, and occurs infrequently.

Perhaps the only route for defense-sponsored R&D to flow out to the commercial market is by employees quitting and starting up their own companies. That has been the route for the merchant GaAs IC business, which started up when Rockwell employees quit to establish the first merchant GaAs chip maker, GigaBit Logic Inc., in 1981. But it's a slow and inefficient process, says Thomasetta, a former Rockwell scientist.

DARPA compromised

As powerful as the defense lobbies are, there once was an agency — DARPA — that could resist all the politics and hand out funds to best stimulate research. But critics point to DARPA's Strategic Computing Program as positive proof that even the nation's premier sponsor of R&D has been compromised in the 1980s.

SCP's stated goal was to advance key information technologies important to the country's economic as well as national security. The plan was to disburse a total of $1 billion to turbocharge U.S. research in technologies such as artificial intelligence, parallel computing and microelectronics.

But unlike prior DARPA programs, in which all funds were earmarked for research, SCP had specific military applications to tackle. The systems, ranging from a "pilot's associate" to a "battle management system" satisfied critics in Defense who argued that DARPA research had no relevance to military systems. But it also sopped up lots of money.

Approximately 25% of the SCP budget goes to developing these specific applications. DARPA asserts that the systems serve to focus the research done in SCP toward generic applications. But critics charge that the applications are too defense oriented with little potential payoff to the civilian sector.

According to economist Flamm, SCP is not an "R," or research, program, as past DARPA efforts were. "It's an R&D program. And it's typical of the basic shift [within DOD] toward development." Although it will result in spin-offs, the trend toward development will dampen the potential, he says. "DARPA's been politicized," says consultant Dimancescu.

But for those who complain about the lack of spin-offs in the 1980s, the biggest boondoggle for spin-offs: the Strategic Defense Initiative. It is perhaps the most controversial defense project ever conceived, and it also draws a large share of military R&D funding today — the electronics and computer R&D represent an estimated 30% of the $15 billion spent on SDI between 1983 and this year. But for those who track spin-offs, SDI is particularly alarming because it is being sold to a wary Congress and public on its spin-off potential.

SDI "will so stimulate the national economy that it will pay for itself," said Lt. Gen. James Abrahamson, SDI's director. Critics contend that this is little more than wishful thinking. All the problems of applications oriented, contractor-performed work are present in SDI, they say — only magnified several hundred times. In electronics and computers, the technologies are more specialized and exotic than ever, boding poorly for commercial applications, claim critics.

Sematech chairman Robert Noyce worries that technology gets trapped inside defense contractors

SDI's supporters, from contractors to Defense officials, say that one of the big spin-offs of SDI will relate to highly parallel systems, used to quickly process the information coming from giant arrays of sensors. They talk about other spin-offs in such areas as higher density, higher speed gallium arsenide ICs and semiconductors that can switch hundreds or thousands of amps of current.

Who cares?

But the commercial world cannot use these developments, critics claim. There's no great need in commerce for highly parallel architectures that can run simple, repetitive algorithms very fast in real-time applications, according to David Parnas, professor of computer science at Queen's University, Kingston, Ontario, and a former member of SDI's Eastport advisory panel. Instead, the need is for parallel systems that can run multiple complex algorithms.

GaAs R&D is likely to proceed without concern for cost, critics charge, while the commercial GaAs market remains fixated on keeping expenses down. And semiconductors that can switch large amounts of current might be useful, but how much are these going to cost?

In software, SDI is trying to do things too quickly with too much money, adds Parnas. "They're getting old ideas, and they're getting bad ideas." SDI, says Parnas, is funding solutions to SDI's software problems that are based on people's promises, rather than critically evaluating whether those approaches will work. Charges Parnas: "The program is being managed by people who don't know very much about the field."

The SDI organization (SDIO) is attempting to disseminate information about SDI technology, to answer critics' charges that research is cloaked in secrecy. The SDIO spent over $1 million to establish a database containing unclassified information on SDI technologies — their Technology Applications Information System — accessible by anyone passing a minimal clearance. But critics charge that the database contains useless information, watered down by the declassification process.

This all leads to one question: Can anything be done to make military R&D result in more spin-offs? Suggestions range from shifting military R&D back toward research to reforming procurement procedures and eliminating the pork barrel. But any changes will take a long time. Working against any changes, says policy consultant Dimancescu, is "the inertia of the system."

Others say that, frankly, it's folly to expect to see commercially important spin-offs from revised military R&D procedures. "If we want to promote the commerce we will do that which has the highest leverage," says Sematech's Noyce, referring to commercial initiatives such as Sematech. If "you doctor up programs that have a different purpose, then you'll fail in both purposes."

Meanwhile — everyone still talks about spin-offs. □

Why technology change is the curse of the laptop class

Six months is enough to obsolete a laptop these days. Pity the vendors as they try to keep up, using everything from upgrades to hiring blitzes

BY JOHN McCREADIE

While industry analysts mull over the arduous task of defining what criteria qualify a computer to be called a laptop, sales of the battery-powered, briefcase-like computers continue to soar. Manufacturers, however, are not as worried about defining size and weight parameters as they are with how to keep up with the rocket-pace of new laptop technologies.

Competition is wolfish, as manufacturers attempt to keep up with the speed of today's booming market, fearful that some newer, more innovative product will steal away their market position. In a bid to preserve their positioning, most laptop makers are modeling their marketing strategies after the laptop's successful predecessor — the desktop computer. In addition, many vendors are trying to position their newer laptops as an end-all product, hoping to grab some desktop market share.

Design Tutorial
Program Tutorial
Design Software
Program Software
Beta Testing
Outline Document
Write and Edit
Proof, Print
Advertising
Design Packaging
Layout
Print

Tom Martin, vice president for marketing and product development for NEC Home Electronics (U.S.A.): "We absolutely think that the appropriate role of the laptop computer is as people's primary computer"

Marc Berlow

Manufacturers are hoping to gain greater market penetration by expanding current product lines, implementing extensive advertising campaigns and increasing product life cycles. But ultimately, the highest success any laptop player will reach inevitably rests on the availability of the newest component technologies. Laptop makers, however, have differing views on how to achieve this.

Surprisingly, two PC leaders are lagging behind the pack. Both Apple Computer Inc. and IBM, which scored poorly with its portable PC entry some years ago, have returned to the drawing boards to beef up laptops they have been developing because they were not competitive with recent product announcements, say industry watchers.

Breaking into the laptop market is important because it is big and getting bigger. Laptop sales in the United States tripled in two years, making it a $1.2 billion industry last year, according to Dataquest Inc., a San Jose-based market research firm. By 1992, worldwide market sales could hit $5.9 billion, of which $4.1 billion will be in the United States, reports Dataquest.

Most credit today's popularity of laptops to breakthroughs in screen technology. "The laptop market is one place where screen technology has really been a driving force," says Kevin Mankin, director of product development at Zenith Data Systems. Likewise, hard disk drive technology has evolved such that drives now require a minimal amount of power, making them very functional in laptop computers. Here, too, the technology is advancing very fast. Newcomer PrairieTek Corp. is now marketing an unprecedented 2.5-inch rigid disk drive that, if it catches on, could open the way for even smaller, lighter and more powerful portable machines. But what laptop makers unanimously say they now desire most is a breakthrough in battery technology.

In order to keep up with rapidly changing designs and technologies, manufacturers are scrambling to find ways to gain a competitive edge with their laptop products. "Because the technology is changing so rapidly, it's almost always possible for someone to beat you on a given feature six months after you launch a product," says Tom Martin, vice president for marketing and product development for NEC Home Electronics (U.S.A.) Inc.

Upgrades

Grid Systems Corp. of Mountain View, Calif., which uses its own salesforce to go directly to end users, makes its 286- and 386-based 1500 series models upgradeable in the hopes of increasing the potential product life of its portables. Its 80286-based motherboard can be upgraded to an 80386 and the hard disk drive is changeable, says Bruce Walter, Grid's senior vice president for sales and marketing.

The current market share leader, Zenith, credits its leading-edge success to putting more emphasis on sourcing components from outside vendors than on internal research, says Mankin, highlighting that strategic relationships with suppliers are especially important in gaining access to new developments.

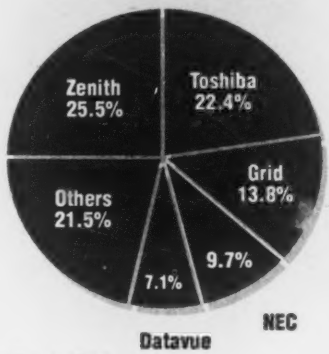
But Toshiba America Inc. disagrees with an outside design integration strategy. The Japanese company, second to Zenith in U.S. market share, is almost entirely vertically integrated and sources out only a few of its laptop components, says Toshiba's director for PC marketing Tom Sherrard.

A few companies, however, admit that the rate of technological advancement is difficult to keep up with. These companies have adopted a different strategy. Take Sanyo Business Systems Corp., for instance. "We're not out to be the cutting edge of technology," says Sanyo's marketing manager Grace Szwagulinski. "We put out a quality product and sell to the niche market." For Sanyo, that niche market includes students and people in small businesses.

Korean conglomerate Samsung Information Systems America Inc., one of the newest players to enter the laptop arena, is, like most manufacturers, distributing laptops through the same channels it established with its PC products. Besides distributing through its usual national and regional distributors, Samsung is going directly to laptop specialty outlets which are slowly springing up around the country, says K.W. Jun, sales and marketing operations director for Samsung.

U.S. laptop market

Share of U.S. unit shipments



Total 1988 market
Units: 723.6 thousand
If-sold value: $1.17 billion

Source: Dataquest Inc.

Because the laptop industry has changed so much in the past two years, manufacturers are using print-media advertising to educate consumers. NEC reports spending $4 million on its current five-month laptop advertising blitz, a substantial jump from the $2 million it invested for the entire year in 1988. Sanyo, which reports monthly increases of 25% in orders for its laptop, has increased laptop advertising by 15% over 1988. Grid is targeting trade magazines with plans to double its current advertising revenue this year.

By 1992, laptops could account for 16% of all PCs sold, up from 7% in 1988

As the marketing focus of the laptop market expands, laptop vendors are also taking aim at a slice of the mainstream desktop market. "We're not talking about just taking share in the laptop market," says NEC's Martin. "We're talking about reconceiving the way computers are used.... We absolutely think that the appropriate role of the laptop computer is as people's primary computer."

NEC offers a "Docking Station" that effectively turns its laptops into desktops. Compaq Computer Corp. also features an optional Desktop Expansion Base with its new SLT/286 laptop; the base provides two full-sized standard expansion slots for special tasks such as micro-to-mainframe interfaces. This means all standard peripherals can remain hooked up to the base while the laptop remains easily portable.

Threat to desktops?

Still, the laptop market is far from controlling the personal computing industry. In 1988, only 7% of all personal computers purchased were laptops, says Dataquest. The researcher estimates, however, that by 1992 laptop market share could increase to 16%.

Unless a manufacturer develops all of its own components, vendors need access to volume quantities of newly developed components to stay competitive. Says Lorie Strong, Compaq's director for product marketing, "We are selling our laptop at a rate higher than we can deliver." One reason for this underproduction is the difficulty in obtaining sufficient VGA page-white displays, according to Dataquest. Adds Grid's Walter: "They are available, but we wish we could get more of them." Compaq has also hired 135 manufacturing employees to help meet the underforecast demand for its laptops.

Conner Peripherals Inc. of San Jose, one of the largest hard disk drive makers for laptops, reports difficulties keeping pace with demand for its 3.5-inch drives, says chairman Finis Conner. Conner's drives consume less than 2 watts of power, a breakthrough that made hard disk drives functional in laptop packaging. But that benchmark is being challenged by PrairieTek. Its 2.5-inch drive, not much larger than a pack of cigarettes, consumes only 1.5 watts of power. PrairieTek expects to finish this year selling 160,000 drives. ☐

Lithium batteries rewrite the rules for laptop makers

NEC has bet on advanced lithium cells for its new laptop, and some board makers are doing the same. But lithium's lead is far from assured

BY BARBARA BERKMAN

These are turbulent times for the lithium battery industry. In the past two years, management shakeups, new suppliers and the first-time commercialization of lithium batteries for the consumer market are demanding heightened aggressiveness from lithium battery makers.

All of which has laptop computer makers and producers of other weight- and power-sensitive electronics equipment asking a lot more questions about the often-overlooked battery business: Should they follow the lead of NEC Corp. in betting on advanced lithium batteries? Will they obtain the same low-weight payoffs? And how can they learn to understand and then exploit this arcane new power technology?

Up to now, nickel-cadmium batteries have been popular for laptops, military communications systems, add-in computer boards and a myriad other areas where low weight and long battery life are important. But the lithium lightweights last more than twice as long — 1.8 watt-hours against 0.85 watt-hours for the type used in NEC's laptop. And when NEC's choice of an advanced rechargeable lithium cell helped whittle its Ultralite to just 4.4 pounds, it rewrote the rules for competing in the fast-growing laptop market and added significant impetus to the battery makers' sales efforts.

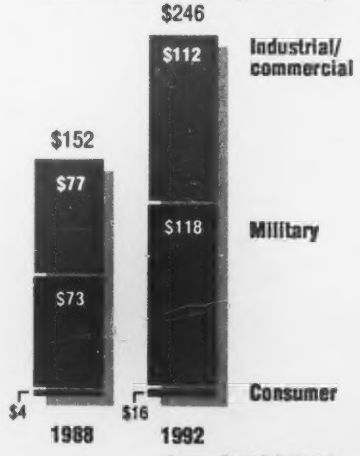
It's not as if battery makers don't have enough to keep them busy. The entry of new players like Eastman Kodak Co., coupled with research that may spawn product development by such nontraditional battery makers as AT&T, have cluttered the market with competition. These newcomers' products are far from insignificant: last year Vancouver, British Columbia-based Moli Energy Ltd., supplier of NEC's batteries, shipped the industry's first commercial rechargeable lithium battery.

And among the giant battery makers, Ralston Purina Co.'s purchase of the Eveready Battery Co. from Union Carbide Corp. in 1986, followed by the mid-1988 leveraged buyout of Kraft Inc.'s Duracell unit, have placed two major suppliers in the hands of new management.

But a lithium battery industry in flux is a boon to electronics manufacturers scanning the market for improved batteries. However, in the race to commercialize new products for miniaturized, portable electronics, development times typically have been slashed to under 18 months, down from as much as four years. And for the first time, joint ventures and nondisclosure agreements between OEMs and battery suppliers have become de rigueur.

Lithium battery uses

U.S. merchant market ($ millions)



Source: Frost & Sullivan Inc.

"Companies are working on new OEM products and new power sources simultaneously," says Barry Huret, assistant general manager of battery sales at Panasonic Industrial Co.

No complacency, please

Indeed, because of the number of new battery products now being commercialized, there is little room for complacency among OEMs. "No potential battery user can afford to keep out of touch with what suppliers are working on in their labs," warns Donald Saxman, editor of Houston's "Battery & E.V. Technology."

Designers from the two industries, however, haven't always worked in tandem. It is a relationship "ripe for miscommunication," explains Michael Bolan, vice president for marketing and development of Dallas Semiconductor. "There's a teaching and education process that the community of lithium battery makers and engineers must go through."

At no time has that learning process been more critical. Industrial battery suppliers are aiming their products at high-margin, high-end applications that pivot upon a close partnership with manufacturers. To succeed, suppliers are bridging the gap between electronic designers' specifications and lithium technology. "Battery development has progressed much less quickly than electronics," says Ken Rekrutiak, marketing vice president of Moli Energy.

Nonetheless, lithium battery sales are growing at 13% to 16% annually, fueled by their improved performance, new applications and the general miniaturization of electronic products. The U.S. market could reach $246 million by 1992, up from an estimated $152 million last year, according to New York market researcher Frost & Sullivan Inc. In

Europe, sales last year of $61 million — with some $34 million fueled by memory backup applications — will mushroom to $104 million by 1993.

Domestically, the use of lithium batteries in computer add-ons is also outpacing growth in other industrial applications. The batteries serve as back-up in case of power failure in systems using CMOS RAM chips.

The U.S. merchant market for lithium batteries is almost evenly divided between industrial and military applications, with each generating some $75 million in sales. Leading suppliers in the industrial market are Wilson Greatbatch, Tadiran Electronic Industries Inc. and Panasonic, while Power Conversion, Duracell Inc. and Saft America Inc. dominate supplies for military applications, according to Frost & Sullivan.

The most explosive growth will be in consumer sales of mass-marketed commodity lithium batteries retailing at a pricey $5 per package. Battling for share in a market predicted to quadruple in sales over five years to $16 million by 1992, are Kodak, which launched a 9-volt battery in 1986; and Duracell, with its line of 3- and 6-volt products. Eveready will foray into the market with a 1.5-volt AA battery due in early 1989.

Yet, the surge in consumer sales will have an impact on industrial market prices because the production processes are different. Industrial suppliers are plowing research dollars into a host of high-end applications: electronic transmitters, digital tape measures, automatic tire pressure equipment and hearing aids that monitor frequency amplification.

Higher volumes

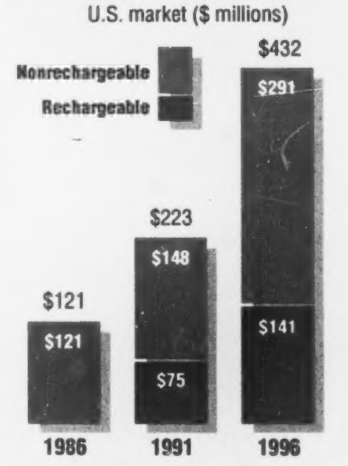
"Potential applications are turning into real applications," promises Edward S. Hatch Jr., marketing manager for industrial batteries at Catalyst Research Corp., a Baltimore-based lithium battery maker. Increased sales volume, as well as improved manufacturing automation, already have helped slash prices on high-volume cells. Recently, Saft, a Valdosta, Ga., supplier, lowered year-end prices by as much as 60%.

While the electronic industry should be hitting paydirt as more lithium batteries trickle into commercial development, some products approach the needs of industrial users — but are still not close enough.

Take the example of chip makers Dallas Semiconductor and SGS/Thomson Microelectronics Inc., two pioneers in packaging semiconductors together with lithium batteries for use in computer board real-time clocks. Dallas Semiconductor's integrated product is smaller than the components purchased separately, and pricer at $12.50 for 1,000 units. Manufacturers benefit from a lower part count and convenient installation. "We don't have to be familiar with lithium technology," says John Rynearson, vice president for engineering at St. Paul, Minnesota-based board maker Mizar Inc. "Our designers get all the specs, they stick it in, and that's it."

Lithium battery sales

U.S. market ($ millions)



Source: Business Communications Co.

Ideal in concept, the actual parts sport some unwieldy features. "Their products have been close, but not quite right," says Force Computer Inc. senior engineer Jim Turley about Dallas Semiconductor's product. He adds the "nonstandard package size, nonstandard device pin-outs and cumbersome programming interfaces conspire to make the part hard to love."

Still, the chip makers' integrated products are gaining market share, and battery suppliers are also muscling into the laptop market with rechargeable lithium cells. When NEC introduced the Ultralite last November, other laptop makers sat up. "We could see switching over," admits Mark Schiebl, product market manager for Grid Systems Corp., a maker of high-performance laptops.

Rechargeable lithium battery technology is compelling. Unlike alternative batteries, lithium's chemistry lends itself to a gauge that lets laptop users know exactly how much charge remains to power the computer, an attractive feature for intermittent users. While priced at $4-$5, as much as 3 times the price of nonrechargeable lithium cells, one Molicel is 65% lighter and one-half the volume of two nickel-cadmium batteries.

Airline restrictions

Yet only a handful of suppliers Altus Corp., Sanyo Energy Corp., EIC Laboratories Inc. among them — are researching or sampling lithium rechargeable batteries. Many others are shunning the technology completely, and for some sound reasons. Federal restrictions limit to 0.5 grams the amount of lithium, per battery, that can be carried on airplanes. NEC secured a waiver of the restrictions, an "arduous," but inevitable process that would be a hurdle for all laptop makers following NEC's lead, warns Paul Cereiko, product manager for the Ultralite.

The recharger itself weighs more than one pound, sacrificing some of the benefits of the lighter lithium battery. The cells also have a wide range of discharge, between 2.2 and 1.3 volts, compared with a flat discharge rate for nickel cadmium, the prevalent laptop power source. Improvements in nickel cadmium technology are also making laptop makers think twice. "Nickel cadmium makers have cranked another 20% capacity out of the same cells each year. It's a race," says Grid Systems' Schiebel. "We need a big jump in cost, performance and advantages to consumers before we shift over."

If they do switch to lithium, laptop makers may well encounter limited suppliers for some time. "Right now, lithium rechargeable batteries is a very small niche inside a very small niche," quotes Gilbert Merritt, Eveready's director of technical resources. That marketing decision may be a laptop maker's lament. Says Cereiko: "Battery manufacturing is critical to laptops," but the ideal battery seems yet to come. Cereiko's wish list? "I'd like them lighter, smaller and more powerful." ☐

Promise and peril for makers of VME board-level computers

Industrial manufacturing continues to pull VME board-level computer growth along. But the low end may be under attack from the ATbus

BY RICK WHITING

A maturing market, a possible shakeout of weaker companies, and a bid to define the future VMEbus architecture all mean that for the VME board-level computer market in 1989, the times they are a-changing.

In 1988, the worldwide market for VME-based products is estimated to have reached some $420 million, with board-level computers (sold for incorporation into complete systems by OEMs) accounting for $135 million of that, according to the VMEbus International Trade Association (VITA). "And there is a near consensus that the VME market's compound annual growth is 31% to 32%," says analyst Rick Main of Databus Market Reports, Santa Clara, Calif.

This year holds promise for VME vendors. Their chief market, industrial manufacturing, is booming, and the 32-bit VME standard continues to make gains against Intel Corp.'s Multibus and other architectures.

But on the down side, there are signs that microcomputer buses are becoming more competitive at the low end. And despite the market's growth, some of the hundreds of smaller companies that compete in the VME board-level computer arena could fall by the wayside as the market is transformed from being technology driven to marketing driven.

"I think there is consolidation within the VME market," says Martin J. Weisberg, executive vice president and general manager of Force Computers Inc., based in Campbell, Calif. "A shakeout is underway [and] we're expecting that to accelerate."

Since its creation in the early 1980s, the VME single-board computer market has become dominated by Motorola Inc., Force, and a handful of other companies. But the huge majority of vendors are small operations, some recording only six-figure annual sales.

Pete Yeatman, marketing vice president for Radstone Technology Corp. in Pearl River, N.Y., believes that despite the market's growth, it is not enough to support the hundreds of vendors competing for a share of that business. What's more, large system vendors such as Masscomp (now merged with Concurrent Computer Corp.) and Sun Microsystems Inc. are increasing sales of VME single-board computers.

"As companies become larger, the business side becomes more important," according to Main, referring to marketing, sales and even legal operations. "That will make it much more difficult for the small guys to compete. With the maturing of the market [and] the sophistication of the customers and competitors, it's certain to drive out some of the smaller companies that are not as competitive.

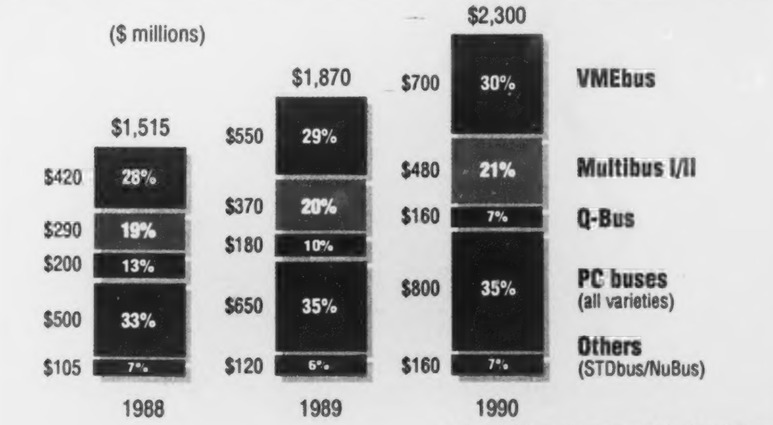
More lawsuits

"And what that means is that we'll see more lawsuits, we'll see lower prices, and we'll see better engineered products and more complete products," says Main. He also predicts greater emphasis on customer service and support, rather than hot technology. "Many vendors are so engineer dominated that they do not even understand the market," he says.

Even leading-edge engineering is putting the squeeze on small companies. Weisberg notes that surface mount technology, software, and gate array design are becoming increasingly expensive and small manufacturers cannot afford the cost.

Furthermore, Motorola does not disclose sales figures, but the company claims to hold a 40% share of the VME board-level computer market, according to Fred Rehhausser, strategic marketing director for Mo-

Worldwide board market by bus architecture



Source: VMEbus International Trade Association torola's microcomputer division.

With 1988 sales of some $60 million (including all VME products), Force claims a 25% share of the VME CPU market. Radstone and Heurikon Corp., Madison, Wis., both claim to hold the third position. Radstone puts its annual sales at about $50 million and Heurikon at $20 million, although neither breaks out VME board-level computer sales or provides market share estimates. Other players include Dy-4 Systems Inc., Ironics Inc. and Mizar Inc.

Formerly the microsystems division of The Plessey Company Plc, Radstone is itself a creature of the evolving market. Plessey had planned to close down the unprofitable division, according to a report prepared by Main, and the division's managers executed a leveraged buyout last May. Radstone Technology Corp. is the U.S. subsidiary of British parent Radstone Plc.

But VITA director Lyman Hevle remains upbeat about the VME market in 1989, believing that the growth rate precludes the possibility of a shakeout. "The market has expanded as fast or faster than the total ability to produce product," he argues.

Industrial automation is the largest market for VME board-level computers and Hevle points to the resurging manufacturing arena as a reason for optimism. Because VME is an accepted industry standard and the architecture is designed for rugged applications, sales to the government and the military are also on the rise.

Yeatman, for example, says that 40% of Radstone's VME board-level business is commercial and manufacturing, 40% is military-related, and the remaining 20% is comprised of "ruggedized" systems for special industrial applications.

Real-time computing appears to be the fastest growing area for VME board-level computers, according to marketing executives at Force, Motorola, and other vendors. "Real time is becoming much more of a strategic market for ourselves, our competitors, and Sun, of all people," Rehhausser says.

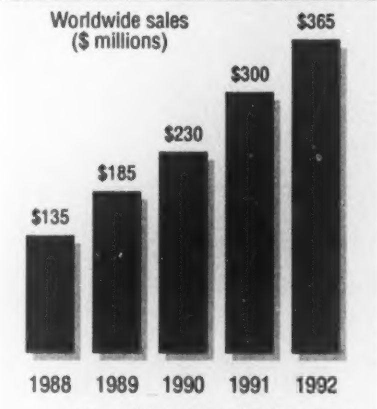
Open hardware

Weisberg says that many users and OEMs that previously relied on proprietary bus architectures are switching to VME CPUs. "I think that thanks to the OSF (Open Software Foundation) and Archer groups, openness is becoming an issue," he says. "More and more of our customers are looking at open hardware as well as open software."

The venerable Multibus I standard promoted by Intel remains a strong seller because of its huge installed base among low-end systems. But the jury remains out on the sequel — Multibus II.

Venture Development Corp. division manager Maurice Klapfish, who follows the VME market, believes that Multibus II is gaining ground within high-end applications and is putting competitive pressure on the VME architecture. But he says it is too early to say if Multibus II will ever overtake VME. Hevle and Main, however, are more skeptical about the eventual success of Multibus II.

VME-based CPU market



Source: VMEbus International Trade Assoc.

"VME will be the lion's share of our business [this] year," predicts president Christopher Priebe of Heurikon, which markets VME, Multibus I and Multibus II board-level products. Radstone markets only VME-based boards and Yeatman agrees: "We get very little or no competition from Multibus II."

Threat to VME

But VME boards are facing a threat from another quarter: the ATbus, NuBus and other microcomputer architectures. Priebe believes that rather than migrating to the higher VME architecture as expected, many current vendors and users of Multibus I are switching to the ATbus.

That does not come as a surprise for Yeatman, who says that for applications not requiring the high throughput or rugged architecture of VME, the cheaper AT architecture makes sense. "If I can do the kind of processing that I need to do on an IBM PC, I'd be a complete idiot to buy a VME product," he says.

For the future, VITA and VME product vendors are seeking to keep the architecture intact by defining the future of the standard and providing technology bridges for migrating from the current specifications.

At VITA, business and technical committees, chaired respectively by Weisberg and Shlomo Pri-Tal, Motorola's manager of systems architecture, have been meeting to define the future standard. In December, VITA decided to base the new architecture on the Rugged Bus and Future Bus specifications established by the IEEE. Hevle says the results, due for release by mid-1989, will result in a bus architecture with "10 times the speed" of the VME's 40 megabytes-per-second throughput.

"What this means is that we can reach applications that we could not even touch with VME," Hevle says of the implications for board-level computer vendors. VME will be repositioned as a midrange or intelligent I/O bus.

Yeatman believes the current standard will still be good for design purposes for about three years. But Priebe says that with powerful RISC (reduced instruction set computer) microprocessors, the likely foundation for future single-board CPUs, a high-performance bus architecture will be a necessity.

While calling the VITA plans "a laudable effort," Main is skeptical that any committee can prescribe a future standard. "They can decide what [the standard] ought to be, but that isn't how the market works." He sees the future bus architecture being shaped by user demand, competition from proprietary architectures and the wishes of major semiconductor vendors — in this case Motorola.

This month Hevle and his equivalent at the Multibus Manufacturers Group will meet at the Buscon show in Santa Clara to discuss the possible merging of efforts to define future standard bus specifications. "Our common enemy is proprietary buses in the open market," he says. ☐

Semiconductor makers bask in the Italian sun

While worldwide chip sales are cooling, they're still hot in Italy. Last year's 50% growth was attributed to the booming domestic high-tech and auto industries

BY ANDY ROSENBAUM

As the gloom begins to gather over the worldwide semiconductor industry, sunny Italy is likely to remain a hot spot. While integrated circuit demand in Western Europe is expected to slow to 11% this year, sales within Italy will increase almost 21% to $1.01 billion, according to Motorola Inc.'s annual survey. What's more, this growth comes on the heels of a 50% jump in 1988.

In general, Italian business is booming, led by a dramatic upsurge in demand for cars and personal computers. Industry is spending up to 10% of its income on capital improvements, a record high for Italy. As a result, the once decidedly low-tech country is starting to catch up with its neighbors. One of the biggest beneficiaries of this boom is SGS Microelettronica SpA, Italy's homegrown supplier which is now part of semiconductor heavyweight SGS-Thomson. SGS controls about 15% of the Italian market, which represents about 17% of the chip maker's $1 billion in sales.

Memories comprise a full one-fourth of SGS' Italian demand, according to Jean Phillipe Dauvin, SGS' chief corporate economist, with microprocessors representing 21%. SGS is optimistic that the growth will continue at a healthy clip. David Gibbons, an analyst with James Capel in London, agrees. "While demand for PCs should not equal that of 1988, there is a consistent need, in both terminals and PCs, for more memory per user," according to Gibbons.

SGS economist Jean Phillipe Dauvin: "Italian electronic industries are growing faster than their European competition"

Oliver Martin/Black Star

PCs in demand

Ing. C. Olivetti & Co. SpA sold about 500,000 personal computers in Italy last year, according to industry sources, despite problems in obtaining DRAMs. "Memory scarcity has had little effect on Olivetti because we have always had long-term contracts with our suppliers," explains Olivetti semiconductor purchaser Piero Giannatempo. "This is equally important since we have to pay special attention in trustworthiness and qualification of our suppliers. So we try to avoid the spot markets."

In addition to information-processing applications, the auto business is stepping up its demand for "smart" electronics for cars. "Almost 30% of our sales go to this sector, in which we expect a steady rise," says Siemens Data SpA commercial director Bruno Fumagalli. The Italian car market is outpacing the European market's boom. While European sales grew 5% in 1988, according to DRI Europe, sales in Italy grew 7.4%.

This is good news for Fiat, which has a lock on more than 60% of the Italian car market. Magnetti Marelli SpA, Fiat's component unit, spent about $40 million on semiconductors last year. "And we expect a 20% rise in sales in 1989," according to business manager Bruno Pechiney. "Up to now we have not had trouble in obtaining supplies," he adds, "since we don't require standalone memories, which have been in short supply." The Fiat unit is Europe's second auto component maker. According to industry analysts, it controls about 56% of the original equipment manufacturers' market for fuel management systems; 50% of Europe's market for dashboard systems; 37% of all steering-column switches; 31% of all headlight systems; 25% of all starters; and 20% of all electronic ignition systems.

Across-the-board investment

Although Fiat is easily Italy's largest company, it is not the only large company here that is spending heavily to catch up in high tech. Industrial leaders spent $3.5 billion (in a country of 56 million people) on data processing and telecom in 1987. "Italian industry is restructuring on the back of strong export demand," says UBS-Phillips & Drew Ltd. analyst Richard Reid. "The battle with unions has been won, and operators are making up for years of underinvestment. They are seeking more professionalism and more marketing, and that means more high tech."

Upgrading and expanding manufacturing accounted for 72% of that high-tech investment. CAD/CAM alone was worth $270 million. "Factory automation is a high-growth area, especially when it can be linked to administration," according to a report by Assinform, an association of data-processing managers. "Integrating office and production management should involve heavy investment for Italian industry."

However, Italian banks also are investing quite heavily in high-technology products. "Italian banks are among the world's most labor-intensive and least efficient credit institutions," according to Gianni Allavena of Milan's SIGE investment firm. "With the specter of 1992 looming, Italian banks are beginning — but just beginning —to computerize."

Networking should also constitute a high-demand area for banks in the coming years. However, the supply of extra services will also require better-functioning telecommunications networks, above all for electronic fund transfer, and Italy's public network currently leaves much to be desired. "The high performance of Italian industry and its increasing adoption of information technology contrasts strangely with the backward public network — either in terms of telephones or of packet switching," according to Milan Technibank analyst Franco Morganti.

IC demand in Italy is expected to increase almost 21% according to one survey

Meanwhile, analysts are projecting substantial spending increases in the services sector, which spent about $150 million for information-processing equipment in 1987, according to the Assinform study. In areas where computers are critical, only 50% of the operators use information technology in Italy. And success in furnishing VAN services is only partial. Evolved forms of processing such as office automation, computer graphics, scientific calculation and archiving have achieved "surprising little diffusion in the service sector," according to Assinform.

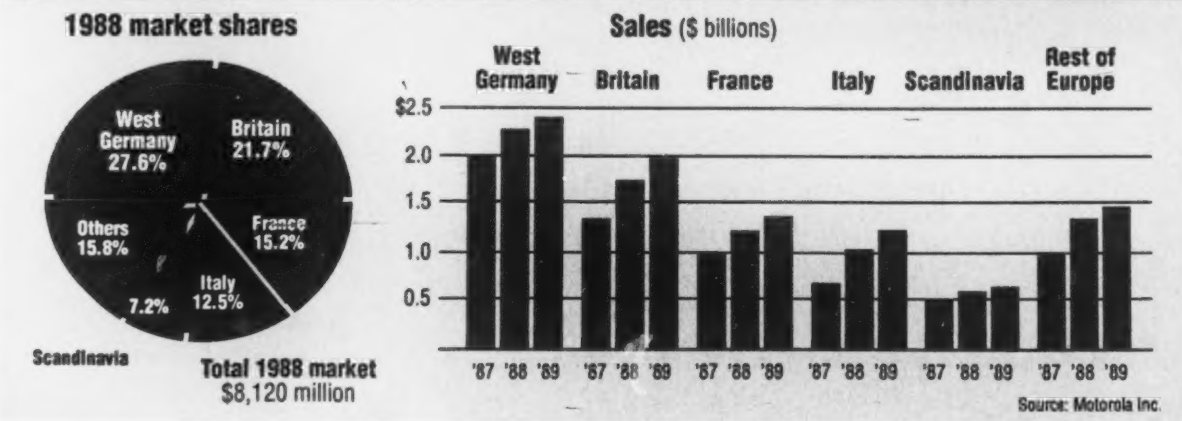
And, in an effort to make its byzantine bureaucracy function more efficiently, the Italian government spent about $1.5 billion in information-processing equipment last year, up 11%. In an attempt to bring government departments on line, the Ministry bought 12,000 personal computers in 1988, 140% more than in 1987, with a corresponding investment in networking technology.

Despite their agreement about the bright local scene for semiconductor sales, SGS and Motorola concur that the worldwide market will grow much more slowly next year. "The coming year will be difficult for the entire semiconductor industry," says SGS managing director Pasquale Pistorio. "We expect computer sales to fall, and growth to be only at about 6% to 7%."

From the vantage point of his Paris office, SGS' Dauvin is a paragon of measured optimism. "Since the Japanese will continue to increase capacity, I expect that the price of semiconductors will fall," he says, "with the 1-megabit DRAM going from about $25 now down to about $15. Obviously that will bring the overall value of the Italian market down." Still, overall volume of sales should remain high," according to Dauvin. "Italy's solid economy ensures that growth will not slow too much," he explains. "And Italian electronics industries are growing faster than their European competition."

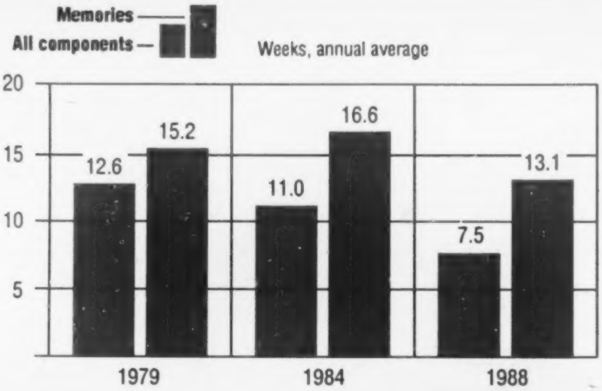
At least SGS executives can count on their local market to run counter to this depressing general trend. ☐

The European semiconductor market by country

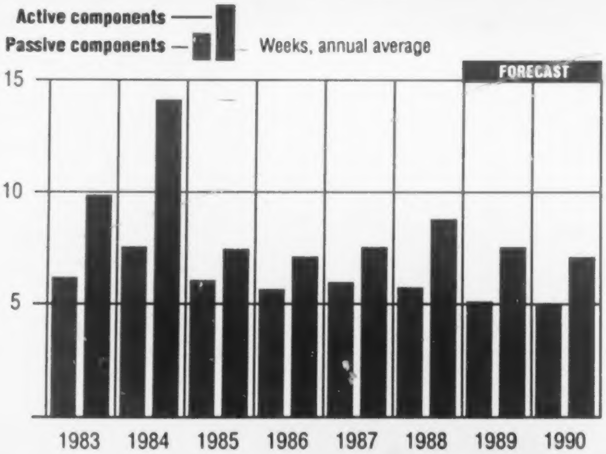


Source: Motorola Inc.

Comparing leadtimes during expansions



Component leadtime outlook



Leadtimes in detail

Weeks, monthly averages	Peak 1983-1984	December 1987	December 1988	1st qtr. 1989
Discrete semiconductors	11.6	8.4	5.5	5.7
Integrated circuits	19.6	7.6	4.6	5.1
Memory circuits	20.4	9.6	9.7	6.9
Microprocessors	24.6	8.6	8.9	6.4
Displays	10.4	9.1	7.3	7.2
Capacitors	10.0	6.9	5.3	5.4
Connectors	10.1	7.2	5.2	5.4
Printed circuit baords	9.4	5.9	5.5	5.2
Relays	11.8	8.1	5.5	6.7
Resistors	8.3	4.6	4.2	5.1
Switches	8.3	6.4	5.5	5.5
Wire and cable	6.7	4.1	3.4	3.5

Historical data: Electronics Purchasing; Forecast: Cahners Economics

Leadtimes reveal some information about outlook

Leadtimes for electronic components averaged seven and a half weeks in 1988, far below the leadtime stretches of previous electronics industry expansion years. That's telling us something about the type of economic recovery the industry went through and what we may expect in 1989.

These leadtime statistics presented here are average length of time between a buyer's placement of an order and the seller's delivery. ELECTRONIC BUSINESS' sister publication, *Electronics Purchasing*, surveys over 500 buyers each month to determine how speedy or slow components are being delivered. The result of this survey: exclusive average monthly leadtimes for over 80 types of electronic components.

This leadtime data offers a snapshot look at demand for a product relative to supply. Back in April of 1984, when supplies were short and demand was high, delivery times for microprocessors stretched to over 25 weeks. A year earlier, buyers of microprocessors had only to wait nine weeks for delivery. Clearly, the supply was completely out of alignment with demand in 1984.

For 1988, the leadtime data is telling a far different story than in 1984. Last year, the highest microprocessor delivery time reached was 10.3 weeks, in August. Indeed, delivery times have been amazingly stable.

The numbers reveal some hints about what to expect this year as well. Because supply and demand have stayed in relative balance, end users have not built up excessive inventories. Back in 1983 and 1984, buyers double- and triple-ordered to protect their production schedules. Not so in 1988. The upshot is that there will be no inventory-led components sales crash this year.

Just-in-time (JIT) inventories have also helped to keep delivery times low in 1988. With a commitment to JIT and now some experience under their belt, electronic manufacturing companies have simply not allowed delivery times to stretch to 1984 highs.

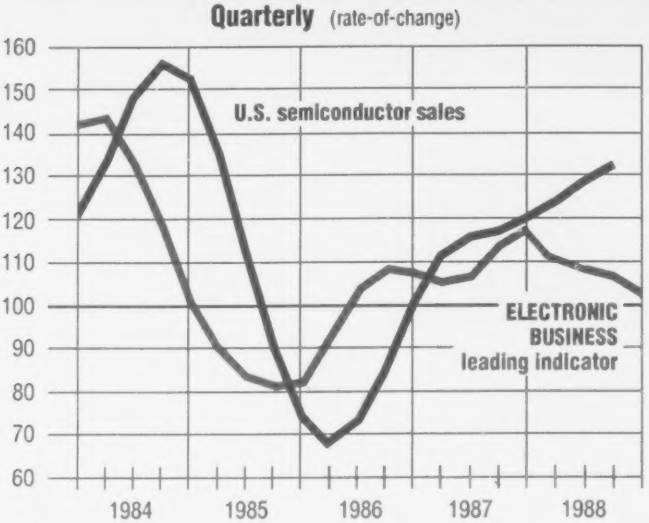
ELIZABETH B. BAATZ

Leadtimes will appear again in the May 1 issue of ELECTRONIC BUSINESS. Note: A monthly subscription to *Electronics Purchasing*'s leadtimes database is available on IBM-compatible diskettes for just $275. To order, or for more information, call Gina Roos at *Electronics Purchasing* at 617-558-4731.

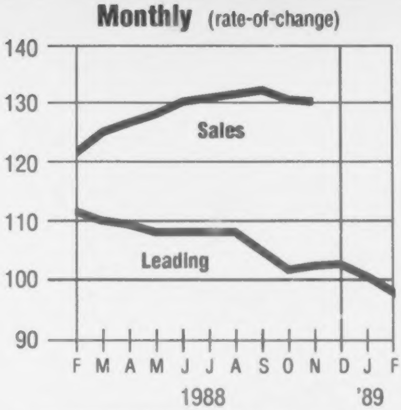
BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368



The ELECTRONIC BUSINESS leading indicator fell to 102.2 in October, down from 105.6 the previous month. Unlike past months, all the components of the indicator contributed to the decline, with semiconductor bookings and company stock prices contributing the most to the fall. The business cycle trough for semiconductors will happen in the first quarter of 1989.

Source: Cahners Economics

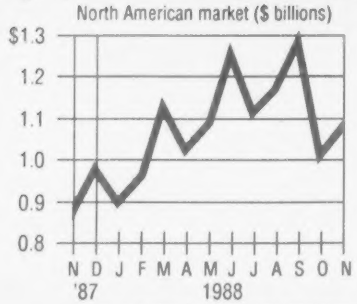
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1987 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Oct.)	102.2	105.6	119.9	111.1
U.S. semiconductor bookings ($ millions, 3-month average, Nov.)	$1,071	$1,064	$999	$951
Weekly hours of semiconductor production workers (monthly average, Oct.)	39.7	39.9	40.4	40.6
Electronic components leadtime index (1977 = 100, Dec.)	89.8	99.8	109.3	100.7
S&P's semiconductor stock price index (1970 =10, monthly average, Nov.)	44.2	48.1	51.1	65.5
Change in electronic components inventories ($ millions, SA, Oct.)	+$96	+$61	+$93	+$41
Contract and orders for plant and equipment ($ billions, SA, Oct.)	$37.8	$39.2	$35.5	$34.6

SA = seasonally adjusted, all other data is not seasonally adjusted

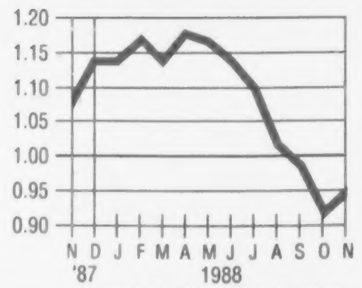
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



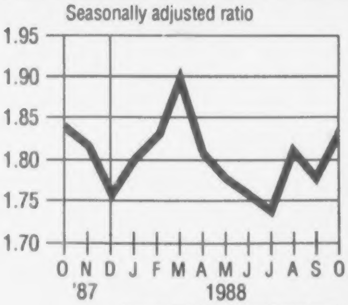
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

FEBRUARY 20, 1989

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Survival strategies for supercomputer wars

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SGS' marketing tactics are "mm, mm good" PAGE

Distributors' profits crisis: One way out

John Rollwagen,
chairman and CEO
of Cray Research

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

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Cray Research is at crossroads

A little less than two decades ago, Seymour Cray invented the supercomputer business. Since then, his company, Cray Research, has defined the market by defining the technology. But things change, and Cray is now threatened by the success of its own creation. Supercomputer sales have mushroomed into a $1 billion business, spawning many new rivals to challenge Cray's leadership.

Even though demand is expected to grow almost 25% a year to $2.46 billion in 1992, analysts agree that the market probably isn't large enough to accomodate the five U.S. and Japanese supercomputer firms (and two "mini" supercomputer makers) currently in it — not to mention the others that are poised to enter the fray. All are faced with pricing pressure, a distinct split between high-end and low-end business and a less sophisticated user base demanding standardized software.

As a result, Cray is at a critical juncture. Like many innovative high-flying companies before it, the supercomputer leader and industry watchers are wondering: Can a firm that virtually created an industry with its innovative technology stay on top once that industry matures? Chairman John Rollwagen is convinced that the answer is yes. Wall Street analysts aren't so sure. Our cover story explores this dilemma from several perspectives.

Ivory tower investments

Electronics firms have been in a giving spirit lately. Top companies donated more than $200 million in cash and equipment to U.S. universities last year. However, most got back more than they received. After Apollo Computer donated two computers to the University of Tulsa's petroleum department, the school spent $415,000 for Apollo equipment and is now eyeing 15 to 20 more workstations valued at as much as $300,000.

Barbara Berkman, associate editor

New ELECTRONIC BUSINESS associate editor Barbara Berkman takes us behind the gambling table of university donations. "Plunk down your equipment or cash and — ideally — walk away with more purchase orders, the best engineering recruits, the latest technology and a sense of corporate citizenry," writes Berkman. But it's a risky, high-stakes business and must be carefully managed like any other resource. Berkman, a seasoned business reporter, joins our staff after stints at *American Lawyer* newspaper and *Dunn's Business Review*.

BETH KARLIN, managing editor

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BPA ABP

University donations are a corporate challenge

The top electronics firms gave over $200 million in cash and equipment to U.S. universities last year. It was worth it, but . . .

James Brill needed a computer network two years ago; he just didn't want to pay for one. A professor of petroleum engineering at the University of Tulsa in Oklahoma, Brill contacted Apollo Computer Inc., Digital Equipment Corp., Hewlett-Packard Co. and Sun Microsystems Inc. and asked each for a donation of equipment to be used for advanced research. "Apollo was the only company to step forward," recalls Brill.

Lucky for Apollo. The two computers it donated worked so nicely that the university's petroleum department purchased six service processor nodes. The chemical engineering department dropped by to watch the system; it then purchased two workstations. Mechanical engineering bought one more. So far, the university has purchased $415,000 in Apollo equipment, and is now eyeing 15 to 20 more workstations valued at as much as $300,000.

For Apollo, a donation program has produced a wealth of benefits, as Brill explains. "We'll probably develop software and talk to our colleagues at other universities. We indirectly help [Apollo] market to the educational market."

Welcome to the gambling table of university donations: Plunk down your equipment or cash, and — ideally — walk away with more purchase orders, the best engineering recruits, the latest technology and a sense of corporate citizenry. But these potential benefits, if realized at all, come at a high price. Donation programs are expensive and must be managed like any other resource. But their goals, such as technology transfer, are tricky to administer and nearly impossible to monitor.

Universities in the United States received some $1.8 billion in corporate donations in 1987 and again in 1988, some $400 million of that in products assessed at fair market value, according to Hayden W. Smith, senior vice president of the Council for Aid to Education. Equipment donations last year declined after a steady upsurge since a 1982 tax law change, with some notable contribution cutbacks by IBM and others.

Why do electronics companies give? IBM, which shelled out a whopping $95 million in worldwide educational donations in 1987, maintains "there is no tie-in between donations and marketing of our product," claims Charles R. Bowen, director of IBM's university relations grant program. Big Blue donates "just out of a sense of corporate social responsibility," he says.

Smith for the Council of Aid to Education can't quite see it that way. "Nonsense. They're doing it for business reasons. There's no such thing as corporate philanthropy."

Those benefits are obvious. Equipment donations are regarded as a solid investment in both educating and making contact with potential recruits. "If students are learning on our tools, when they graduate, they are instantly productive," notes Jim Hill, corporate grants manager of Mentor Graphics Corp. Mentor also is betting that students weaned on its equipment now will purchase Mentor products on behalf of future employers later. And there are tax benefits: The cost and one-half the difference between the production cost and fair market value is deductible.

Contributions to education by top electronics companies

	Contributions[1] ($ millions)
AT&T	$40.0
Digital Equipment	50.0
GM Hughes Electronics	4.8[2]
General Electric	17.2
Hewlett-Packard	46.0
Honeywell	2.4
IBM	63.1
Motorola	1.9[3]
Xerox	50.0[4]

[1] Equipment noted at fair market value. 1987 latest figures available

[2] Excludes $287,400 in equipment at production value

[3] Semiconductor equipment only

[4] In cash and equipment since 1984

Source: ELECTRONIC BUSINESS

Laughingstock

But equipment donations are not trouble-free. Companies must commit to maintaining the equipment they install, or else their products and investment could fail. Explains Pierre Bouchard, grant program administrator for Apollo, which donated some $10 million in equipment last year: "If a donation isn't well managed from our side, instead of equipment being a shining spot at a school, it can become a laughingstock."

Technology transfer, a popular goal of donation programs, is particularly difficult to administer. Companies complain that one headache is the orchestration of a regular exchange between academics and executives, and suggest implementing monthly meetings. DEC, for one, makes sure technology gets back to the company. It designates an engineering group as sponsor of specific grants, and then demands a fee — a percentage of the grant awarded — to ensure the group has a direct interest in actively monitoring the research.

Even when technology is transferred, the pace is often sluggish. Donors are at the mercy of the academic calendar, notes Robert M. White, Control Data Corp.'s chief technical officer: "In industry, if we have a problem, we can throw resources at it and get an answer quickly."

But White adds that university technology may come as a bargain compared with in-house research. "In some sense it's a good deal. Here you have access to the world's experts . . . and we can not afford to have experts in all our areas."

The greatest challenge of donation programs is convincing top management of the program's validity. Corporate giving will always be an undocumentable allocation of resources, laments Apollo's Bouchard. "I have to show what returns I give the company from the program. The program's ink is black, but it's not as black as other departments."

BARBARA N. BERKMAN

Are there too many supercomputer makers?

The influx of Japanese and low-end manufacturers will likely lead to a shakeout. Cray prepares for a fight

Despite the "us" versus "them" attitude surrounding the supercomputer industry today, supercomputer makers on both sides of the Pacific are facing similiar problems that have more to do with business than with economic or technological might.

Market leader Cray Research Inc. and ETA Systems Inc., the Control Data Corp. supercomputer subsidiary, have much in common with the Japanese supercomputer troika of Fujitsu Ltd., Hitachi Ltd. and NEC Corp. All are faced with pricing pressure due to increased competition, a definitive split between high-end and low-end products and a less sophisticated user base demanding standardized software.

And while the supercomputer market is expected to grow 23.4% compounded annually, from $1.06 billion last year to $2.46 billion in 1992, according to Dataquest Inc., a market research firm in San Jose, most analysts agree that it's not large enough to accomodate the five suppliers currently in it. Early this year, Alliant Computer Systems Corp., one of two "mini" supercomputer makers, laid off almost 20% of its workforce to restore profitability in the face of cutthroat pricing.

American companies are poised to enter the fray. The computer division of Evans & Sutherland Computer Co., in Mountain View, Calif., will deliver its first supercomputer later this year. And Supercomputer Systems Inc., founded by former Cray designer Steve Chen and financially backed by IBM, will be unveiling a system in 1992.

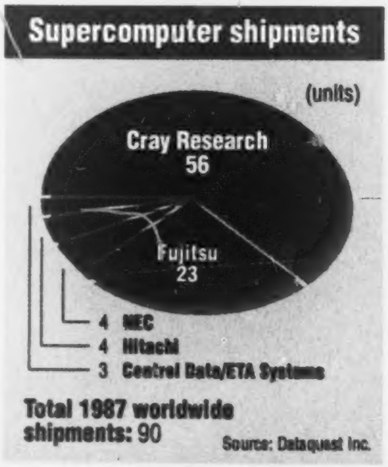
Lock-out

Both Japanese and American suppliers also face a virtual lock-out in each other's markets. It is difficult at best for either Cray or ETA to sell into Japan and it's almost impossible for Fujitsu, Hitachi and NEC to sell into the U.S. Fujitsu has sold two sytems in the United States; NEC has leased, not sold, one sytem and Hitachi has yet to install in the U.S.

Admittedly, the roadblock into the U.S. has been set up by the U.S. government, which has encouraged supercomputer users to buy American. "There is a great deal of government concern that these very large Japanese companies could squeeze out small U.S. companies," says Christopher Willard, a senior industry analyst with Dataquest.

But Japanese companies have encountered other problems in the United States. "The Japanese have had a difficult time in the U.S. because their machines are too expensive," contends Willard. A single central processing unit from NEC, for example, says Willard, costs about $22 million, while a comparable configuration from Cray is priced at around $17 million. The Japanese companies have been quick to discount but can only go so far without annoying Uncle Sam.

Initially, Fujitsu and Hitachi offered compatibility to IBM's mainframe operating system in a marketing debacle uncharacteristic of Japanese companies. Scientific and technical users, the bread and butter supercomputer users, could not have cared less about IBM-compatibility.



Source: Dataquest Inc.

Late last year, reports indicated that NEC might withdraw from the U.S. market altogether if its joint marketing venture with Honeywell Inc. didn't bear fruit after the Japanese company's next-generation machine is introduced early next year.

Samuel Adams, vice president for marketing operations at HNSX Inc., the joint venture in Burlington, Mass., says such a decision has not been made. But he does concede it is possibile if business doesn't pick up. "There's no business in the world that can survive five years without selling anything," he says.

They will return

But no one would count the Japanese companies out of the U.S. market. "They are now preparing Unix and a lot of software applications," says Jean-Yves LeClerc, president of Evans & Sutherland's computer division. "They will be back with strong price/performance in 1991."

ETA, the only other American supercomputer supplier shipping systems today, has suffered from some of the same problems as its Japanese counterparts. The company has been slow to move to Unix and its dependence on outside suppliers for some software technology has caused delays.

Now ETA is working to port as many application packages as possible to its system. "You have to have enough critical mass to attract vendors," says Stephen Lewis, ETA's general manager of industry marketing. In addition, new users are adamant about standards and ease of use. "Once the pioneers have been satisfied," says Lewis, "the next buyers will be more demanding."

While ETA has been successful with its low-end, air-cooled $1 million machine, the market has not responded as well to its high-end ETA 10 system. Last year, the company sold seven high-end systems. In the meantime, ETA has lost at least five accounts to Cray, concedes Lewis. But ETA is more concerned with its Japanese competitors. Lewis says that while today's largest market for supercomputers is virtually owned by U.S. suppliers, tomorrow's largest market — the Far East — is owned by Fujitsu, Hitachi and NEC.

ANNE KNOWLES

Fiber-optic LAN makers search for new markets

Fiber-optic networks are considered expensive for desktop applications. But vendors are optimistically seeking niches and standardizing products

BY DWIGHT B. DAVIS

Fiber-optic communications technology has begun to shine in metropolitan and long-distance telephone applications, but its success to date in the local-area networking data-communications market has been less than sparkling. Some LAN vendors now hope to change that picture by better targeting niche applications suited to the light-transmitting medium, and by uniting behind a nearly complete interconnection standard: the Fiber Distributed Data Interface (FDDI).

From 1987 to 1988, fiber-optic LAN revenue was expected to grow 58.3%, from $70 million to $111 million, according to projections made by Dataquest Inc. last June. Still, that $111 million would represent just 4.3% of the total U.S. LAN market, which was expected to reach $2.58 billion last year.

The market for fiber-optic LANs can be broadly divided into low- and high-end camps, says Kim Myhre, vice president for research and consulting at the Business Research Group, a Cahners Publishing Co. subsidiary. The low end consists of Ethernet-type and token-ring LANs running over fiber at speeds of 10 megabits per second (Mbps) or below; the high end encompasses several proprietary networks with 50-Mbps or greater bandwidths and the 100-Mbps FDDI emerging standard.

By definition, the low-end LANs don't take advantage of fiber's most apparent strength — its high-speed bandwidth potential. Instead, the lower speed LANs highlight other fiber-optic characteristics, including the medium's immunity to electromagnetic interference, its resistance to unauthorized tapping, its ability to operate over long distances (by LAN standards), and its compactness relative to coaxial cable.

Premium price

These selling points are important at the low end because the cost of fiber-optic LANs continues to exceed that of networks based on coaxial or twisted pair media. For example, 10NET Communications, a division of Digital Communications Associates Inc., offers a 10-Mbps fiber-optic LAN in which each connection costs $1,295 per node. The firm's coaxial Ethernet connections, on the other hand, sell for $695 each.

Given this cost differential, 10NET is focusing on the security advantages of fiber optics, notably its lack of electromagnetic emissions that could be surreptitiously intercepted. This characteristic is especially important in many military and government applications, which together constitute "a huge marketplace," according to 10NET president Greg Goodall.

10NET has installed "tens of thousands" of 1-Mbps fiber-optic LAN nodes, mostly in government applications, according to Goodall. This lower speed 10NET LAN is available in a version that meets Department of Defense Tempest security requirements, and is currently installed in agencies such as the Air Force Electronic Security Command and the Federal Bureau of Investigation.

The newer 10-Mbps 10NET LAN will also be offered in a Tempest version. In addition, to further enhance the inherent security aspects of the fiber medium, the company is developing the 10NET Secure LAN, which will add data encryption to the basic LAN capabilities.

"We expect the secure local area network develop-

Jugtar S. Basi, VP at Artel Communications: "It's a joke for companies to say that they have FDDI available today"

Dave Bradley

ment effort to yield tremendous rewards as federal agencies and the banking community begin to realize the significance of true data security and integrity," Goodall says. The banking and financial marketplace for fiber LANs is just beginning to develop, but has great long-term potential, according to Goodall.

On the factory floor

Aside from secure applications, fiber-optic LANs were expected to proliferate in factory environments where electromagnetic noise from machinery can sometimes interfere with electrical LAN signals. Some manufacturing plants have installed such LANs — Proteon Inc. of Westborough, Mass., for example, has placed fiber-optic versions of its ProNET-10 LAN in factories since 1983 — but the market hasn't developed as rapidly as some anticipated.

Part of the problem can be traced to the dominance of the coaxial-based MAP protocol in factory settings, says analyst Myhre. In addition, he points out, Digital Equipment Corp. has always had a major presence in manufacturing plants, and has successfully promoted the use of the Ethernet coaxial network in such environments. Nevertheless, Myhre and others believe factories represent one of the niche markets where the strengths of fiber will sometimes outweigh its costs.

As for the typical office environment of networked personal computers, not even the most ardent purveyors of fiber-optic technology see much of a near-term opportunity. "There will be no great demand for running fiber to the desktop," says Howard Salwen, Proteon's founder. "The technology is still too expensive relative to plain wire."

All this adds up to a legitimate, but limited, marketplace for low-speed fiber-optic LANs. As one measure of its limits, Hal Spurney, director for marketing at Fibronics International Inc. in Hyannis, Mass., estimates only 5% to 10% of the popular Ethernet LANs are likely to ever convert to the fiber medium. As a result, many vendors are focusing their attention at the high end of the market, where the FDDI standard is just beginning to take hold.

Under development for several years, the FDDI is broken into four standards that define basic physical, logical and data management criteria for establishing a 100-Mbps fiber-optic network. Three of these four standards — two that encompass the physical connection specifications and one that defines a token-passing protocol for the network data — have been ratified by the American National Standards Institute (ANSI).

The fourth standard — that of station management — handles such tasks as fault isolation and coordination of the other standards' operation, and is not yet formally established. The current unavailability of the fourth piece of the FDDI puzzle has resulted in various claims and counterclaims about products said to be FDDI compatible.

"It's really a joke for companies to say that they have FDDI available today," says Jugtar S. Basi, vice president for business development at Artel Communications Co. Basi concedes that "FDDI is not yet signed off." Spurney at Fibronics is more optimistic. He argues that FDDI-based products can be sold now, with the software-oriented station management standard added later.

In this regard, Spurney draws an analogy between the introduction of FDDI and the earlier debut of the Ethernet LAN. "People were shipping Ethernet products in 1980, even though the Ethernet standard [in the form of IEEE 802.3] wasn't formally established until 1985," he notes.

First chip set

Fueling the rush to FDDI is the availability of the first chip set to implement the existing portions of the standard. Advanced Micro Devices Inc. of Sunnyvale, Calif., has a five-device Supernet chip set which sells for $625 each in 100-unit quantities, and is expected to significantly reduce the price of FDDI-type interconnections.

A number of fiber-optic component and networking vendors intend to make use of the AMD chips. These include beta test sites Hewlett-Packard Co., which manufactures fiber-optic transceivers, and Proteon, which offers a proprietary 80-Mbps network that it says can be upgraded to FDDI.

AMD anticipates that FDDI-based products will account for $150 million in revenue in 1989, with the bulk of the products incorporating the Supernet chips. By year end, the price for a single FDDI connection should fall to the $7,500 to $10,000 range, predicts Bert Williams, strategic marketing manager for AMD's High End Networking Group.

To reach that level, prices will have to drop significantly. Fibronics is selling the first product based on the AMD chips — the FX8210 Ethernet-to-FDDI Learning Bridge — for $24,900. The device connects Ethernet/IEEE 802.3 networks to an FDDI fiber

Howard Salwen, Proteon's founder: "There will be no great demand for running fiber to the desktop"

Dave Bradley

"backbone" type of network.

Such backbone applications that link two or more lower speed LANs via a high-speed fiber network represent one of three potential FDDI markets, according to most industry participants. Along with the LAN-to-LAN backbone sector are the interconnection of clusters of mainframes and minicomputers and the linking of high-end workstations such as those from Sun Microsystems Inc. and Apollo Computer Inc.

The most likely promoters of FDDI for "back-end" computer clustering are the major CPU vendors themselves, such as IBM and Digital. "All the major computer manufacturers have endorsed FDDI, but none are yet offering products," notes Myhre.

How well FDDI will penetrate these back-end applications remains an open question, however. "Within the computer room, you can often use wire just as easily as fiber optics," says Salwen at Proteon. "We prefer a mixed media approach in which we use wire when we can in order to save money."

The LAN-to-LAN backbone marketplace is where most of the current FDDI development activity is concentrated. The relatively high costs of connections into FDDI networks can be more easily justified if each connection interfaces with an entire LAN.

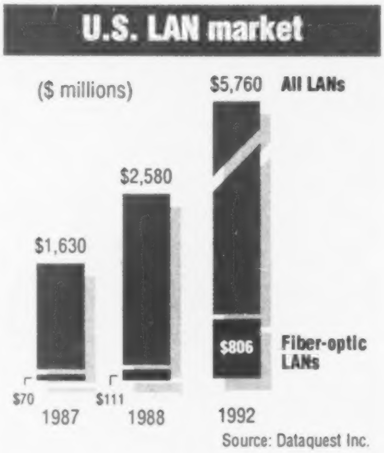
Because Ethernet networks are the predominant LAN in the marketplace, most high-end fiber-optic vendors are concentrating on linking these types of networks via FDDI backbones. Such fiber connections are able to extend Ethernet networks — normally limited by their transmission/collision detection technology to intra-building installations — over several kilometers.

In the long run, the local networking of high-speed workstations could become the predominant FDDI marketplace, but not without a struggle. Connection costs will have to drop significantly before users can cost justify workstation-to-FDDI links, and some are doubtful of the prospects.

"FDDI will be far more expensive than people initially anticipated," believes Salwen. Even though the integrated AMD chips cut costs compared with a discrete component approach, other necessary high-cost devices such as optical transmitter and receiver pairs and circuitry to drive the 100-Mbps network operation will limit the potential price reductions, he says.

Salwen also says that the yet-to-be-defined system management portion of the FDDI standard will require its own dedicated CPU to operate efficiently. "You might use a 68002-level board to run the system management, but such a board lists for about $2,500," he notes.

Even if single connection prices fall to the $7,500 to $10,000 range that AMD's Williams expects by year-end, few workstation installations could afford them, Salwen believes. He says users would prefer to spend about 10% of the cost of a workstation on a communications peripheral, although they might be willing to pay as much as 25% for such a device. "If workstations cost from $15,000 to $20,000, the LAN connections should cost about $3,000 to $4,000," he says. "It's tough to see how we will get to that level with FDDI."



Source: Dataquest Inc.

Split opinion

Even if the cost issue is surmounted, FDDI faces another potential barrier to its widespread implementation. This barrier has as much to do with politics as with technology, and has resulted from a split in opinion about what features a high-speed fiber-optic network should provide.

The FDDI standards development effort broke into two camps early on, according to Artel's Basi. One group, known as FDDI I, was very data oriented and eventually prevailed in establishing its criteria as the current FDDI standard, he explains. The second group, FDDI II, was more interested in offering multiple services, such as voice and video, as well as data over fiber. Basi says many people from this group have since moved to back an emerging IEEE fiber-optic standard — 802.6 — that offers such mixed service at 100-Mbps and 150-Mbps transmission rates.

Not surprisingly, according to Basi, most computer vendors back the data-oriented FDDI standards, while the IEEE 802.6 effort has gained the support of the regional Bell Operating Companies and other telecommunications-based vendors. Basi says it is unclear to what degree the two standards might compete.

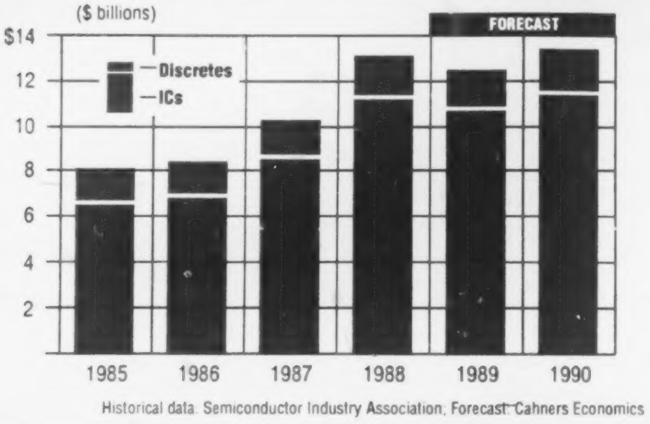
For its part, Artel has positioned its 100-Mbps FiberWay optical network products to conform to the mixed-service approach embodied in the IEEE 802.6 development, although Basi says the company will also offer FDDI once it is fully defined. "We could put 802.6 over our FiberWay networks today without pulling out any equipment," he says, "if there was an 802.6 bridge product available."

Most other fiber-optic networking vendors acknowledge that the FDDI and 802.6 standards could compete in some areas. But they argue that, for LAN applications such as back-end computer links, backbone LAN connections and workstation networking, the data-oriented FDDI approach makes the most sense.

Given the remaining uncertainty about the details of high-speed fiber-optic networking, some users are positioning themselves to take advantage of any future developments. "Since the biggest cost of networking is running the cable, companies are attempting to put in a cable plant that will last for 20 years," says Graeme Plant, marketing product manager at Hewlett-Packard's Roseville Networks Group.

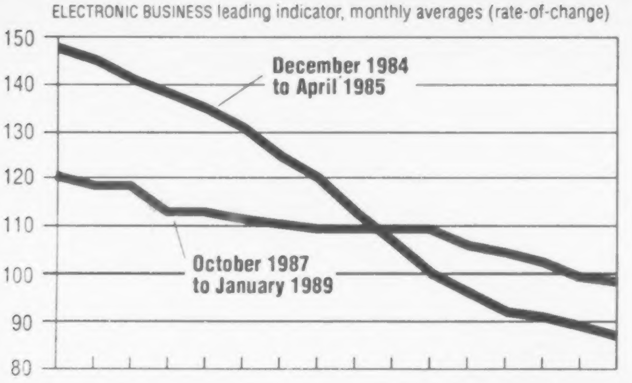
For LAN vendors, the safest and most successful approach is to offer products that can run on either electrical wire or on fiber-optic cable, says Proteon's Salwen. "The fiber nodes may represent only a small proportion of the total number of LAN nodes installed," he says, "but you may still need fiber in your bag of tricks to make the sale." ☐

U.S. semiconductor sales outlook



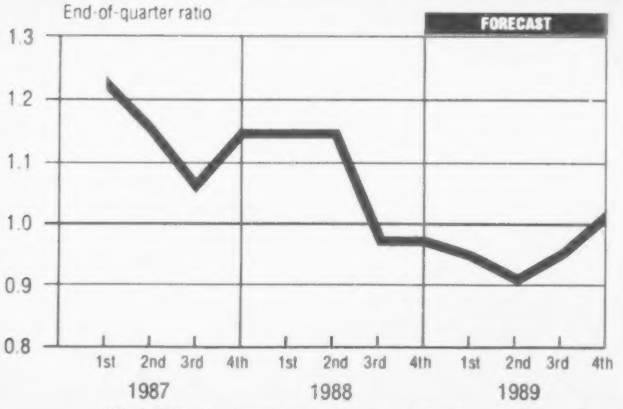
Historical data: Semiconductor Industry Association; Forecast: Cahners Economics

Two semiconductor downturns



Historical data: ELECTRONIC BUSINESS

U.S. semiconductor book-to-bill ratio



Historical data: Semiconductor Industry Association; Forecast: Cahners Economics

Why the semi industry won't crash again

Everybody's speculating about a crash in the U.S. semiconductor industry. Industry leaders are gun-shy and, after the experiences of 1985, understandably so. But evidence is mounting that no crash is in the offing.

Cahners Economics' forecast for semiconductor sales continues to call for a 5% drop in 1989 and a 7% gain in 1990. The slight decline expected this year could be a bit deeper if prices fall further than expected. If prices stabilize, that decline could disappear as well. The key to the outlook: Price changes will determine the eventual outcome of dollar sales this year. Unit sales of semiconductors won't grow much, but they won't fall far either.

All signs point to moderation

The foundation for this forecast rests on several facts. First, look at the ELECTRONIC BUSINESS leading indicator. Back in January 1984, the ELECTRONIC BUSINESS indicator peaked at 147 and fell 41% over the next 15 months.

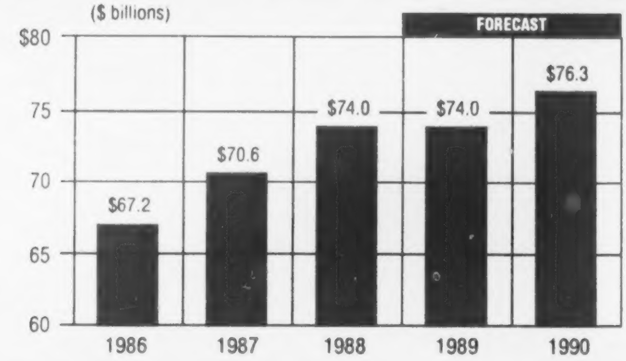
This time around, the ELECTRONIC BUSINESS leading indicator peaked at 120 in October 1987. In the 15 months since hitting that high, the ELECTRONIC BUSINESS indicator has fallen 19% — only half as much as the 1984-1985 slide. If the ELECTRONIC BUSINESS leading indicator maintains its predictive power, it clearly says semiconductor sales growth will fall, but not as far down as in 1985.

One of the critical elements of the ELECTRONIC BUSINESS leading indicator is the inventory of electronic components. With 20/20 hindsight, we know that a severe inventory cycle pushed the semiconductor industry down four years ago. Now, by all accounts, inventories have been managed much more efficiently. The result means no serious inventory overhang and no crashing halt to semiconductor production.

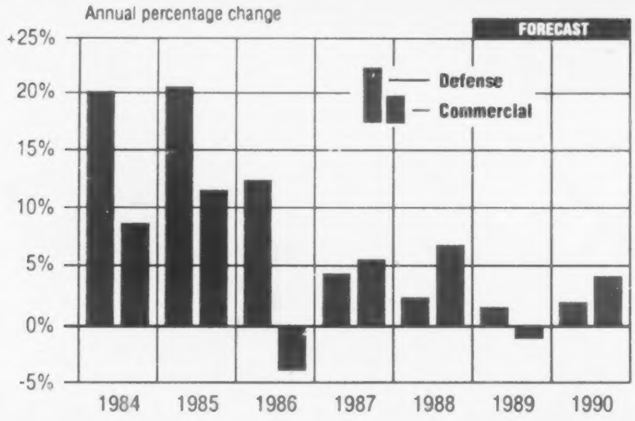
Everything about the nature of the 1988 upswing in semiconductor sales points to moderation in any downturn in 1989. Delivery times for components — even memories — were shorter in 1988 compared with 1984. The value of the U.S. dollar was low, prompting vigorous export growth. All in all, it was a more sane, more manageable economic environment for semiconductor makers in 1988, and the same can be expected in 1989.

ELIZABETH B. BAATZ

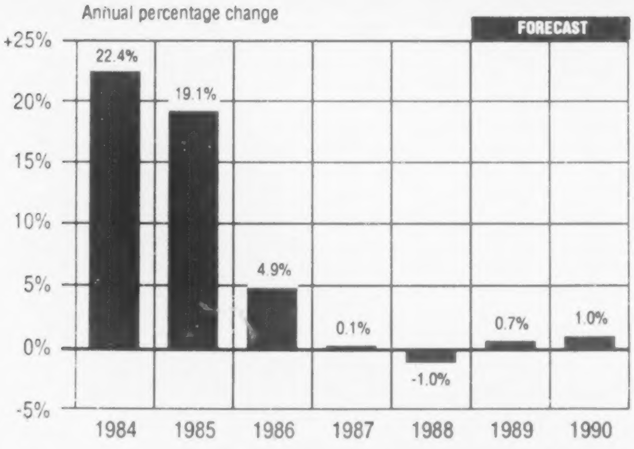
Communication equipment shipments



Defense versus commercial shipments



Communication equipment backlogs



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Going gets tougher in communications

New orders for communication equipment had a flurry of activity in November, rising 26.2% from October to reach $7.67 billion. A large defense order produced this one-month jump as it did back in April of 1987, when total new orders surged to $7.18 billion from only $4.47 billion the month before.

Because of defense procurement, monthly new orders for communication equipment can be erratic. However, the longer term trend is clear. Growth in new orders peaked back in the first quarter of 1988 and has been shrinking ever since. Most of the contraction is in orders for military equipment, but growth in new orders in the commercial sector has also now passed through its peak phase. Don't look for more than a 1% increase in new orders for nondefense communication equipment this year.

Shipments of communication equipment dropped a meager 0.7% from October to November, to $6.07 billion. That's just 1.7% ahead of billings back in November 1987. After growing 12% in 1986 and 4% in 1987, shipments of defense communication equipment increased only about 2% to 3% in 1988 and are expected to inch up just 2% this year. Sales of commercial communication equipment climbed a stronger 6% to 7% last year, but are forecast to actually fall 1% in 1989.

Headed for a difficult year

Business investment in equipment is forecast to increase just 1% to 2% from 1988 as buyers react to increased interest rates and a slowdown in demand for their products. In the third quarter of 1988, business purchases of communication equipment reached an annualized $36.4 billion (constant 1982 dollars), or roughly 2% above the same quarter in 1987. However, the growth rate was down from the 7% hikes in both the first and second quarters of last year.

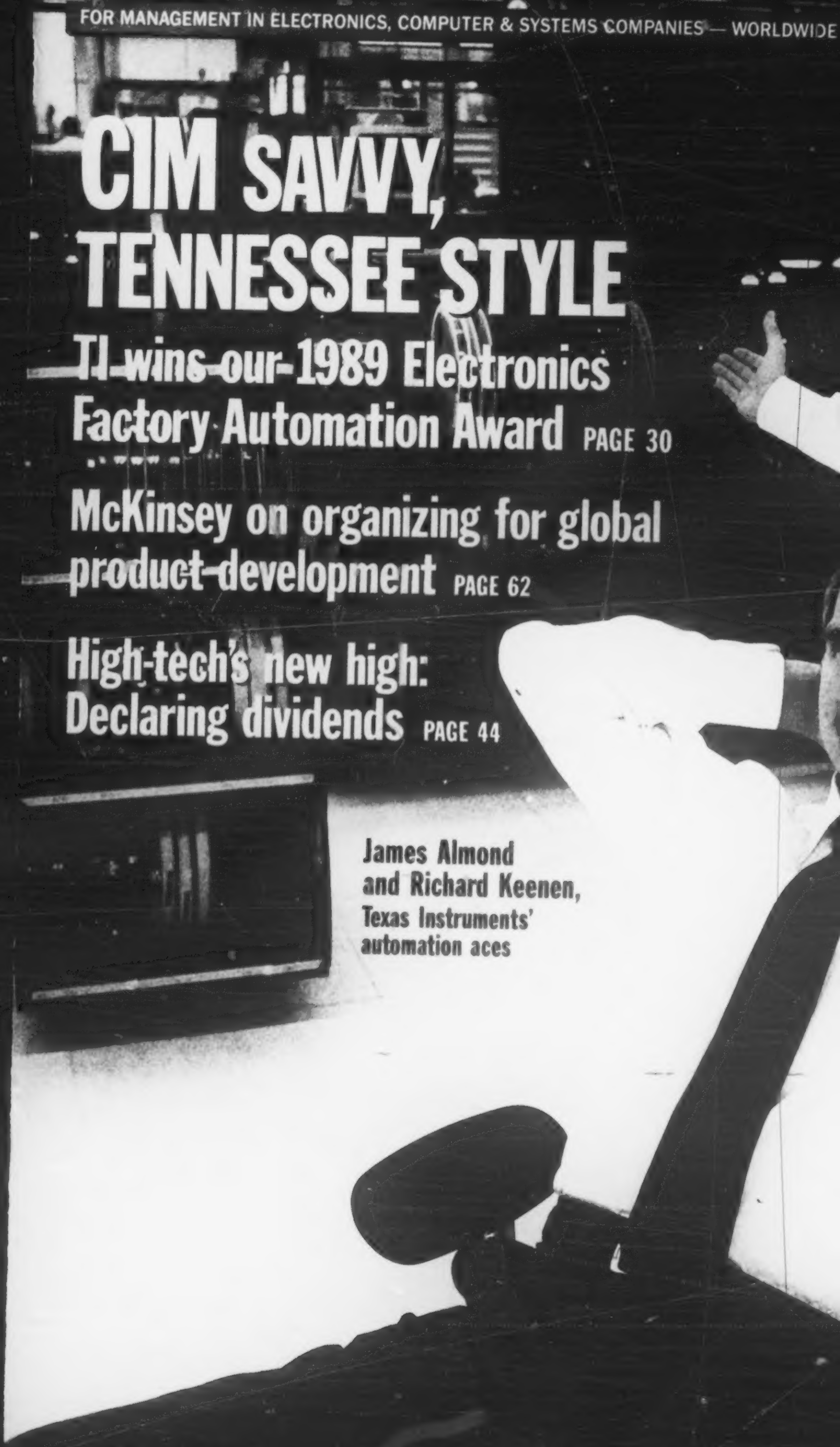
Furthermore, the communication equipment industry is plagued by relatively low backlogs. At the end of 1986, unfilled orders totaled $67.2 billion. Backlogs were flat in 1987, but in 1988, unfilled orders dropped about 1%. Not surprisingly, the stagnant growth in backlogs is largely the result of shrinkage in the military sector.

MADELINE FRANCHI

SIX DOLLARS

Electronic

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE



CIM SAVVY, TENNESSEE STYLE

TI wins our 1989 Electronics Factory Automation Award PAGE 30

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James Almond and Richard Keenen,
Texas Instruments' automation aces

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MARCH 6, 1989

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 15, NO. 5 MARCH 6, 1989

PAGE 30 TI's James Almond (seated) and Richard Keenen: CIM savvy, Tennessee style, leads to factory automation award

David Luttrell

COVER STORY/MANAGING RESOURCES

30 CIM savvy, Tennessee style

There is a heaven in today's world of manufacturing. It is a place where people supervise the making of a product without actually manufacturing it. That place is Texas Instruments' SMT circuit board facility in Johnson City, Tenn., which wins the ELECTRONIC BUSINESS 1989 Electronics Factory Automation Award. With no help from CIM gurus, TI's automated facility is an object lesson in how to implement state-of-the-art manufacturing.

BUSINESS TRENDS

15 Digital audio tape storage systems hit the market

Start-up GigaTrend leads the way, developing its own data DAT offering, despite lacking a standard design format. With at least 15 other manufacturers slated to introduce products this year, the question is: Will GigaTrend be competitive?

20 What does your annual report say about you?

More than $2 billion is spent by electronics firms worldwide to produce corporate annual reports that range from glitzy artistic creations to boring lists of numbers. Often the message from management to investors is miscommunicated.

24 U.S. firms want to be as European as croissants

Electronics companies such as IBM, Altos and LSI Logic are boasting a new quality — their Europeaness. The American firms are busy plotting strategy to position themselves for post-1992 Europe.

MANAGING RESOURCES

30 CIM savvy, Tennessee style

Texas Instruments — winner of the 1989 Electronics Factory Automation Award — makes many flavors of circuit boards for a mix of customers at its CIM facility in Johnson City, Tenn., ensuring its place in the contract-manufacturing business and pioneering TI's use of SMT.

40 Generic pallet power works for Compaq

No longer does the big Texas firm have a palletful of production problems. With its new, self-designed "hot" pallet system, Compaq now can assemble its computer anywhere in the world.

44 High tech is high on declaring dividends

Smaller technology companies — seeking to retain loyalty in a market harsh on high tech and hooked on takeovers — are finding it fashionable to reward shareholders with periodic cash payments, while at the same time attracting institutional investors.

62 Organizing for global product development

McKinsey & Co. consultants, in part three of a series, say changes in the international electronics market dictate changes in strategies — challenges that call for innovation in the very process of innovation.

STRATEGIES

71 DEC: The unlikely hero in telecom

Digital stood by and watched as other computer makers were rushing into telecommunications, and it's not sorry. Marketing rather than making telecom equipment has proved more profitable.

76 Birth of a business: AB's escape route from resistors

Using technology it developed years ago, resistor maker Allen-Bradley is gambling that molded circuit boards will be big business by 1993.

PAGE 88 MiniScribe's Jim Steger and Paul Lyons: Switching production was a good decision

PAGE 106 NuGroup's Gerry Laws: NuBus is not growing as rapidly as hoped

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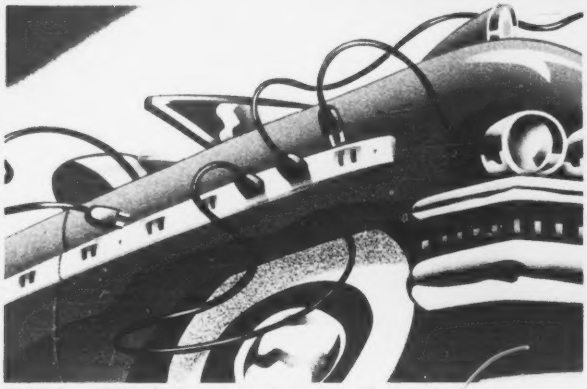
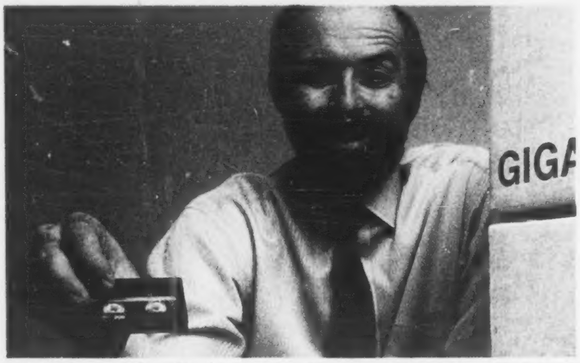
PAGE 24 Altos' Archie Thomas: Aims for semi-independent European operation before 1992



PAGE 94 Multiplexing untangles mess of wires in cars



PAGE 15 GigaTrend's Lee Elizer: Confident data DAT demand will be strong

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85 Why Du Pont had to do R&D in Japan

Du Pont Electronics' shimmering $128 million R&D lab near Tokyo is more than just a research center. It is a statement that executives say is necessary for Du Pont to maintain its position in the increasingly important electronic materials market in Japan.

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TI sets the pace for factory automation

For years, manufacturers have been dreaming about the factory of the future — a paperless facility where interactive computers control and monitor everything from design to purchasing to billing to inventory control to production. While the truly paperless factory largely remains a dream, much progress has, in fact, been made on computer-integrated manufacturing.

To reward CIM pioneers, ELECTRONIC BUSINESS and its sister publication, *Electronic Packaging & Production*, each year grant their "Electronics Factory Automation Award" to the U.S.-owned plant they believe provides the most outstanding example of automation in action in the electronics industry. The 1989 winner is Texas Instruments Inc.'s circuit-board facility in Johnson City, Tenn.

Anne Knowles, senior editor

Since it came on stream in 1987, TI's custom manufacturing SMT line has produced 250,000 boards of more than 30 types. Complexity of products produced on the flexible electronic manufacturing assembly cell has ranged from automotive window controllers to boards for high-resolution graphic workstations with component densities running from 20 components to over 500. The facility is expected to increase output by 70% this year. Moreover, it has returned more than double the modeled after-tax ROI in the more than 18 months is has been in operation. Assistant editor Tony Greene went to Johnson City for a first-hand look at TI's success story, and his observations are in this issue's cover story.

When most major computer companies were jumping into the telecommunications equipment market, Digital Equipment Corp. countered the trend. When competitors were entering the market for private branch exchanges, for example, DEC executives made a decision that would direct DEC's future strategy: DEC — then, now and always — would not manufacture telecom equipment. Instead, DEC opted to customize products if necessary, find experienced partners, and always, always adhere to standards.

This strategy has paid off. While others have demonstrated that computers and telecom don't mix, DEC has — by staying out of telecom equipment manufacturing — built one of its largest industry marketing groups and gained the confidence of telecom suppliers and customers. And it has avoided the expensive mistakes others have made. EB senior editor Anne Knowles reports on this successful strategy.

BETH KARLIN, managing editor

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Digital audio tape storage systems hit the market

GigaTrend leads the way, with at least 15 others slated to introduce products this year. But will they be competitive?

Digital audio tape storage systems have arrived. In the next few months, users who want to take advantage of the high-capacity storage capabilities of this technology will have a number of sources and design formats to choose from. But if it's standards you want, DAT's going to take some time.

With more than 15 manufacturers eyeballing the data DAT market, views differ on how to best implement design formats. During 1988, potential data DAT manufacturers organized themselves into two well-established camps, both aiming at defining a single standardized format.

Although both sides have differing views on format design using a 5.25-inch form factor, they agree that data DAT is an ideal technology for reliable computer storage offering users up to 1.3 gigabytes of memory. And because data DAT uses the same transport mechanism as consumer DAT drives, it is in a prime position to profit on economies of scale if — and when — the consumer market takes off in this country.

But for the time being, data DAT will have to go it on its own in the United States because litigation threats from the recording industry are effectively keeping the consumer DAT market closed. And until consumer digital audio products are produced in volume, thus reducing the component costs, data DAT may have a difficult time competing with the popular, low-cost 0.25-inch and 0.5-inch tape drives now being used in the workstation and small minicomputer markets.

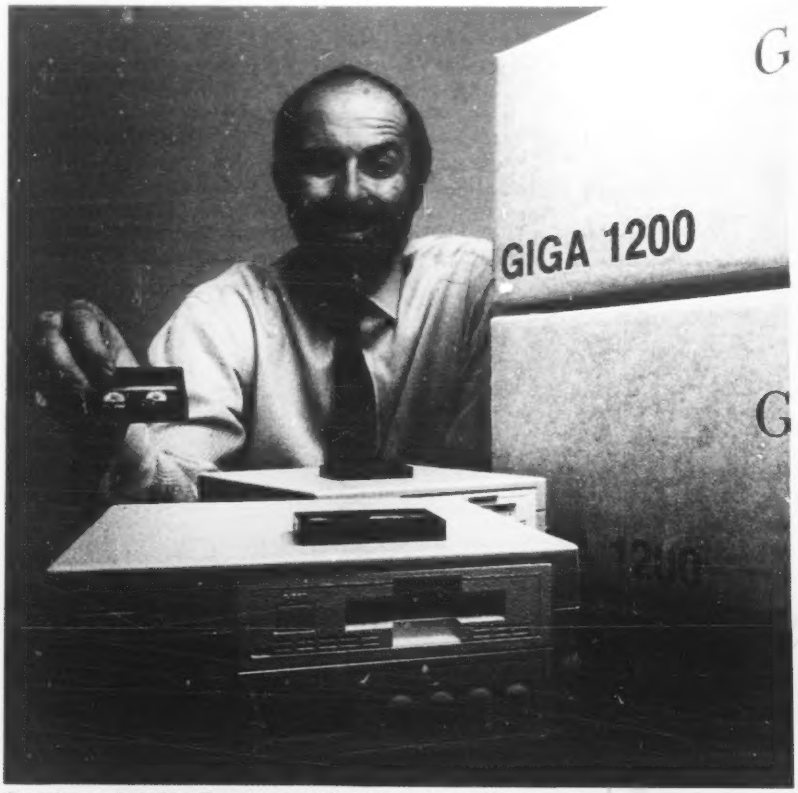
Although the DAT storage market is still untested, the large number of potential manufacturers and end users attending format group meetings indicates stakes are high. The worldwide market is projected to grow from 21,000 units in 1989 to 585,000 in 1993. Total market revenue is expected to increase from $30.4 million to $351 million during the same period, according to Freeman Associates Inc., a Santa Barbara, California-based market research firm. Freeman researchers estimate that by 1993, the data DAT market will secure a 16% unit market share of the entire computer tape storage market, estimated at 3.6 million computer tape drives for 1993.

While industry analysts are unclear regarding which format will be accepted by the American National Standards Institute, they do not rule out the possibility of a split decision, that is, the possibility of more than one standard being accepted. But, they add that it could take until 1990 or 1991 before the issue is resolved.

In one corner, being managed by a Hewlett-Packard Co. and Sony Corp. joint effort, is the Digital Data Storage (DDS) format group, currently with 10 licensed member companies. On the other side of the ring is the Data-DAT (DD) group, being supported by such heavyweights as Apple Computer Inc., Hitachi Corp. and Toshiba America Inc.

Differences in the two designs essentially boil down to two features: the DD group offers a changeable random-access mode and higher data integrity. DDS group spokesman Bert Vermeulen, product marketing director for the Bristol, England, division of HP, counters that those features are overkill and that "it is more complex to build a format that way, causing capacity and transfer rates to go down dramatically." But the DD format can also be driven in a streaming mode similar to that of the DDS format, with a competitive transfer rate.

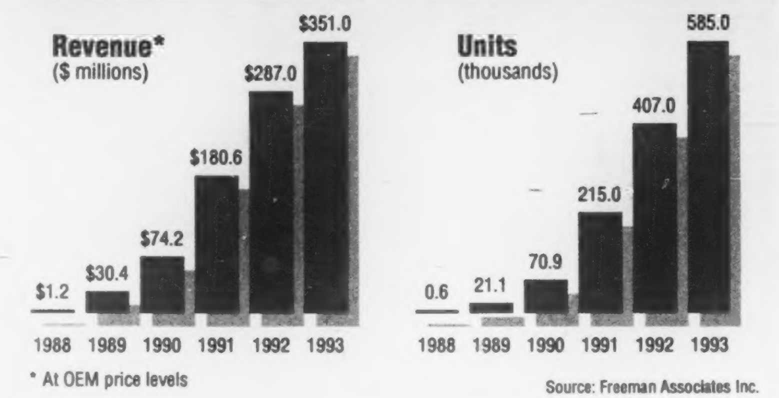
While DDS proponents view market applications as "primarily backup," the DD group also sees a need for imaging applications that



First to market, GigaTrend is confident that data DAT demand will be strong, says marketing chief Lee Elizer

Robert Burroughs

Worldwide data DAT tape drive market



* At OEM price levels

Source: Freeman Associates Inc.

can be retrieved and altered. Memory-intensive medical brain scans stored on the DD format can be accessed by a patient's name and changed, for instance. Thus, a key difference will be the added costs observers predict the DD format will demand to support its higher integrity and read-write mode — a cost, observers say, that will vary from manufacturer to manufacturer.

Market strategies

Market timing is important to many suppliers and some feel the standards process hampers their ability to get a product out fast. "The DDS format is more developed," says Louis Domshy, director for marketing for WangDAT Inc. in Costa Mesa, Calif. "It's the easiest vehicle to get into the marketplace quicker."

While the issue of standardization is being wrestled with, one start-up company has developed its own data DAT offering. GigaTrend Inc., a Carlsbad, Calif., active DD supporter, recently launched its own format drive, priced at over $2,500 for OEM level quantities and $4,200 for single sales. "We have gone to market with our product with the full realization that when the standard is developed we will offer that particular format as an extra format on our drives," says Lee Elizer, executive vice president for marketing and sales at GigaTrend. While Elizer cannot estimate the cost of adding an additional format, he believes it to be inexpensive.

"DAT will be expensive coming in and will have difficulties competing early on," says Richard Young, Hitachi's director for marketing in Torrance, Calif. Several manufacturers estimate the hardware to cost in the range of $1,500 to $2,000, but expect that will come down, especially if the consumer market moves forward.

Besides targeting the workstation and small minicomputer markets, companies such as HP will concentrate on local area networks. HP's Vermeulen views the LAN market as a gateway to the vast PC market. And companies such as Alps Electric (USA) Inc., which make DAT mechanisms for both the consumer and data storage markets, are biding their time waiting for both markets to take off. Alps even has a 3.5-inch mechanism which data DAT manufacturers say they won't implement until next year, assuming the 5.25-inch market catches on.

Even though many data DAT manufacturers will use consumer media priced at about $10, media-maker Carlisle Memory Products Inc. reports it has developed an upgraded media for computer storage which it estimates will cost about $20 per cartridge.

Meanwhile, most in the industry believe a single standard is best for both manufacturers and users alike, but not all agree such a feat can be accomplished. Says Dataquest Inc. analyst Louise Biggs: "I don't think that any one format will become standard. Some will have a stronger market share, but there are too many players, too many opinions and too much at stake."

JOHN MCCREADIE

Strong consumer demand will bring data DAT prices down

You can't do DAT, or at least that's the song being sung by the recording industry

Threatening lawsuits, record companies have been successful in stifling DAT system sales to the U.S. consumer market, despite their success in Japan and West Germany. Because the recording quality of DAT is nearly perfect, fears of copyright infringement and loss of record and compact disc sales have prompted the industry's strong resistance to the technology.

But without the volume potential of the consumer market, the cost of data DAT devices will be markedly higher and could have an impact on the ability of drive makers to successfully compete in other tape storage markets.

Views, however, differ regarding the degree of that impact.

"Because the consumer mechanics is only 30% to 35% of the storage drive, if they don't meet their consumer targets, it's going to be 'so what,' " says Lee Elizer, marketing executive VP at Carlsbad, California-based GigaTrend Inc.

Quarter-inch tape drive maker Archive Corp., a Costa Mesa, Calif., licensed DDS player, says the consumer market will "significantly impact the price of these drives." Says Archive's director for marketing Rich Peters: "The longer it takes the consumer side to get to full volume, the harder it will be on [data DAT manufacturers]."

Hitachi Corp.'s director for marketing, Richard Young, says that company will carry over as much as possible from the consumer side. He estimates that figure to be as high as 50%. So, he remains positive: "DAT on the consumer side is going to be here some day." ☐

DEC: The unlikely hero in telecom

When other computer makers were rushing into telecommunications, DEC held back. And it's not sorry

BY ANNE KNOWLES

Digital Equipment Corp. long ago made the decision to stay out of the market for telecommunications equipment. When the market for private branch exchanges, the telephone switches installed at customer sites, looked ripe for the taking a few years back, DEC executives mulled over the possibilities and made a decision that would dictate the computer maker's approach to the telecom market for years to come: DEC — then, now and always — would not manufacture telecom equipment.

Instead, telecom became one of DEC's 10 major industry marketing groups. The company decided it would continue to sell to telecom customers such as AT&T and the Baby Bells by customizing its products if necessary; partnering with experienced players when possible; and always adhering to standards, according to Dan Latham, DEC's director of global telecommunications industry marketing.

DEC made the right decision. Other companies in the industry have demonstrated that computers and telecommunications don't mix. The two technologies may be becoming increasingly hybrid, but the two businesses — sales, marketing and such — react to one another more like oil and water than bread and butter.

Computer makers are successfully selling datacommunications products, such as local area networks; and low-end voice communications products, such as modems; but high-end telecom equipment and services are another matter. IBM — which has had one communications misadventure after another — divested itself of its myriad voice communications businesses last year after selling its stake in MCI Communications Corp. and its Rolm division to West German telecom supplier Siemens AG.

By staying out of the manufacture of telecom equipment, DEC has avoided the expensive fiascoes others have endured. More importantly, by remaining on the periphery of such a competitve industry, the Maynard, Mass., computer maker has gained the confidence of telecom suppliers and customers. In the process, DEC has built one of its largest industry marketing groups, second only to manufacturing, according to analysts. Neither DEC nor market researchers will estimate the computer maker's sales to telecom customers, but Jonathan Fram, technology analyst with Bear Stearns & Co. Inc. in New York City, says DEC's sales to the telecom industry are likely over $1 billion a year.

Dan Latham, DEC's director of global telecommunications industry marketing: "We will not build major solutions without customer involvement"

Dave Bradley

DEC's dogma

"Our top level corporate objective is to be a good partner," says Bill Kania, group manager of DEC's Telecommunications Systems group. The three rules to that, says Kania, are "don't compete, don't make exclusive deals and give your partners platforms to develop applications." Another rule, says DEC's Latham, is to not develop products in a vacuum. "We will not build major solutions without customer involvement."

"DEC is everybody's ideal partner," says Ken Hoyt, manager for telecommunications industries at Arthur D. Little Inc. in Cambridge, Mass., "because they don't do exclusive deals with anyone." The computer maker, "has a willingness to work with so many people flexibly."

That includes deals with most major telecom companies, including foreign telephone agencies, or PTTs, such as the West German Bundesposte; all of the Regional Bell Operating Companies (RBOCs); and telecom equipment suppliers such as British Telecommunications Plc, Northern Telecom Ltd. and Siemens.

Some are traditional original equipment manufacturer arrangements, like the one with Siemens, which embeds DEC's PDP-11s in its packet switches. Most deals, though, are joint development or marketing of software solutions. "DEC is well-positioned with the best third party in the industry," says analyst Dave Power, vice president of the information technology group at the Lexington, Mass., consulting firm of Temple, Barker & Sloane Inc. "And that's Bellcore," the research company established by the RBOCs.

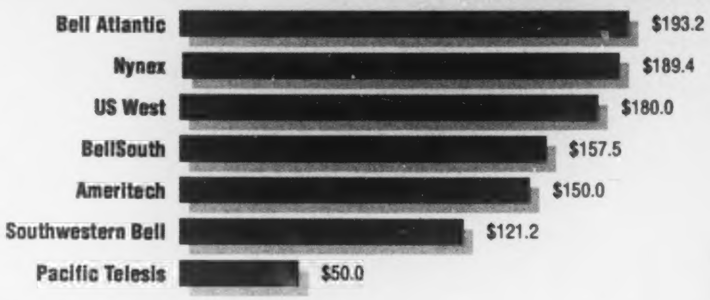
All current joint development work is in software, says Kania. DEC and Pacific Telesis Group, for example, have jointly developed an electronic mail package that was originally intended for internal use at the San Francisco-based PacTel, but will now be used externally as a customer service since the RBOCs were granted admission into information services.

"At the time we started looking" for a partner in 1984, says Jeanne Bracken, director of message handling at PacTel, "not a lot of vendors had a strongly expressed endorsement of standards." DEC did and PacTel signed up with the computer maker in May of 1987. DEC's early commitment to the Open Systems Interconnect, or OSI, standard, says Bracken, sealed PacTel's decision to work with DEC to develop an electronic mail package.

Joint hardware development work between DEC and a partner is rare. However, the exception is AT&T, which is one of the company's three largest customers, according to DEC. AT&T and DEC jointly develop central office applications using DEC VAXs which allows the telecom carrier to retain rights to the products.

The RBOCs: A DEC telecommunications target

Baby Bell's 1987 office equipment budgets ($ millions)



Total for the RBOCs: $1,041.3 million

Source: Company reports

Due in part to its relationship with AT&T, DEC has the largest installed base of computers in the telecom industry, analysts and DEC executives agree. "Because DEC's installed base is so significant," says Power, "there is a lot of opportunity."

Knowledgeable networks

Today, that opportunity revolves around the intelligent network. Right now, most telephone networks are hard-wired. If a carrier wants to offer a new service, central office switches have to be reprogrammed. Phone companies, bombarded by competition from one another and from private networks that "bypass" public lines, want to be able to offer new services more quickly and flexibly using networks with more intelligence.

DEC has the largest installed base of computers in the telecom industry

The question remains, though, exactly where the intelligence will reside. "Which will do it?" asks Power. "Computers or communications?" Switch makers want to do it, says Power, but have not been successful with similiar projects in the past. In addition, there are so few switch makers that telecom companies are wary of placing their hopes with them. "The option is to keep switches as is," says Power, "and put intelligence in a central processing unit that has an open architecture."

"It has yet to be determined," says DEC's Kania. "Today, switches handle it, but our customers say they won't in the future." Kania says the solution may be a coupling of computers and switches. "We are in alliances with switch vendors," says Kania. "We are working with them to hook switches and computers together to distribute data."

So far, DEC has announced one joint development arrangement — with switch maker DSC Communications Corp. in Dallas — and is talking with a number of other switch vendors, says Kania. DEC also has developed, but has not yet announced, a version of the common programming language for switches, known as CHILL, for its VAXs. DEC jointly markets intelligent network applications with BellSouth International.

Another interesting opportunity for DEC, says analyst Power, is tying the network environment to a phone company's customer service department. Now, billing, service, engineering and other departments at a phone company are discrete islands of automation. Connecting them, with access to the same database, would enable phone companies to speed up and expand their service in the same way intelligent networks will.

To do that, phone company management "will want access to huge databases," says Latham. That may create the biggest opportunity of all for DEC. "That opens up a whole new market for workstations." ☐

Apple and Next back NuBus, but EISA is holding it back

The long-ignored 32-bit architecture looked so promising when it was adopted for the Mac II. But wilder market forces are at work

BY RICK WHITING

Riding on the coattails of Apple Computer Inc.'s Macintosh II, the market for third-party products based on the NuBus architecture is booming. But NuBus has yet to catch on outside of the Macintosh market, and its backers say that confusion created by the proposed Extended Industry Standard Architecture (EISA) is to blame.

"It is not growing as rapidly as we had hoped," concedes Gerry Laws, chairman of the NuBus Manufacturers and Users Group (NuGroup), which is promoting NuBus as a standard. "The advent of EISA has made everybody jump back and reevaluate the situation. That's really muddying the waters right now."

Developed at the Massachusetts Institute of Technology in the late 1970s, NuBus was commercialized in a limited way by peripherals vendor Western Digital Corp., and then by Texas Instruments Inc. in its artificial-intelligence workstations. But NuBus remained in relative obscurity until 1987, when Apple incorporated it into the Macintosh II.

NuBus boosters see the bus architecture as both the heir-apparent to the venerable ATbus in the PC market, and an alternative to other 32-bit architectures used in industrial and manufacturing control systems and workstations.

Backers thought the PC market would be the first to embrace NuBus because it provided a natural growth path from the 16-bit ATbus, according to Mizar Inc. chief executive Joseph Ramunni, who serves as NuGroup's promotions director. The 32-bit NuBus offers high-performance throughput and, because of its simple design and connector specifications, is easier for system vendors to implement.

But that was before EISA and IBM's Micro Channel Architecture (MCA) entered the fray. Last September, nine microcomputer companies, led by Compaq Computer Corp., endorsed development of the 32-bit EISA bus as an extension to the ATbus. The move is an effort to capitalize on doubts about IBM's use of MCA in most of its PS/2 line of personal computers.

Laws and others in the NuBus movement say the EISA proposal has caused a number of companies that were considering NuBus systems to delay committing themselves to the architecture. "It's clearly holding up the NuBus," Ramunni says.

Compaq, for example, had been designing PCs based on NuBus early last year before opting to move for the EISA standard. Although a NuBus system was technically feasible, according to systems engineering vice president Gary Stimac, it would be incompatible with the huge catalog of add-on products for AT systems and that it made more sense to extend the ATbus architecture.

At Apollo Computer Inc., personal workstations marketing manager John Davis says there is an "ongoing evaluation" of EISA and NuBus for possible use in Apollo workstations. Currently, Apollo's low-end systems offer the ATbus while high-end workstations use the VMEbus.

Davis says that the high performance of NuBus is offset by EISA's

NuGroup's chairman and senior member of TI's technical staff, Gerry Laws: He had fun, fun, fun till EISA took his NuBus away

Scot Hill

planned compatibility with the ATbus, and that a final decision will hinge on the technological superiority of NuBus versus the marketing advantages offered by EISA.

NuBus has been slow in winning acceptance among vendors of high-end systems, where the VMEbus now reigns. Last year saw few NuBus-based system unveilings, with the October debut of Next Inc.'s workstation being the major exception.

Next's hardware engineering vice president, Rich Page, says the company chose NuBus for its workstation largely because third-party product developers are familiar with the architecture. Next's NuBus differs from other implementations in that it uses CMOS technology rather than bipolar devices to interface with the backplane, and in that its 25 MHz clock rate is two-and-a-half times faster than the proposed standard.

As the bus battles rage, many vendors are sitting on the sidelines trying to pick a winner. By all accounts, the share of the board-level product market held by NuBus remains small. Databus Market Reports, Santa Clara, Calif., estimates that in 1988, NuBus accounted for just under 4% (about $50 million) of the total $1.256 billion worldwide market.

The NuBus market is, nevertheless, expected to grow rapidly despite being largely confined to the Macintosh II. Richard Bloss, a project director with the Frost & Sullivan Inc. research firm, is projecting worldwide sales of NuBus board-level products to grow from $33 million in 1987 to $220 million in 1992 — with most of that growth coming in the later years. Ramunni says the consensus is that NuBus will become "a multi-hundred million dollar market over the next three years."

Estimates of the number of vendors developing or shipping NuBus products for the Mac II range from 100 to several hundred. "I think the Macintosh by itself will carry a large part of the [NuBus] market," according to Bill Nowlin, engineering vice president at National Instruments, which markets data acquisition and instrument control cards for the Macintosh II.

The recent development of NuBus interface chips by Texas Instruments and VTC Inc., Bloomington, Minn., is also expected to boost the NuBus industry by making it easier for vendors to develop add-in products for NuBus systems.

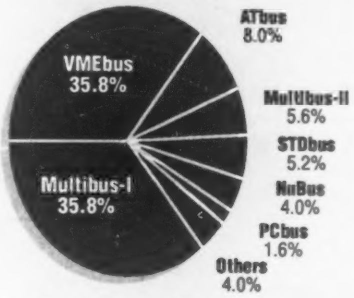
"There appears to be a lot of interest in it," says Brian Kelly, section manager for advanced bus interface at TI. "We think that our chips are going to help a lot in getting the market to grow [and] it looks like a good business for us."

NuBus backers remain steadfast in their belief that the architecture has a bright future. Most are confident that a breakthrough system using the bus — most likely a workstation being developed by a major unidentified vendor, Laws says — will make its debut this year and crack the market wide open.

"Long range, I still think it has potential," Laws says, adding that NuBus is making headway in such areas as embedded systems in military avionics and telephone switching gear. NuBus products developed for the Mac II range from processor boards to signal and image processing cards.

It's easy to miss the NuBus

Worldwide board-level bus market



Total 1988 market: $1.256 billion

Source: Databus Market Reports

"I think that if some workstation vendor or PC vendor comes out with a NuBus system, that will open things up," Ramunni agrees. Mizar, Carrollton, Texas, markets a line of board-level processors using the VMEbus and STDbus and is developing a line of NuBus board-level products for debut later this year.

Boost from Next

Next's use of NuBus could give the architecture a boost. A spokesman for Prime Computer Inc., for example, says the Next workstation "has piqued our interest [about NuBus] and we are investigating" its possible use.

Texas Instruments now markets several specialized systems incorporating NuBus: the Explorer and MicroExplorer symbolic processing workstations, (the latter a Macintosh II with a Lisp coprocessor) and the Unix-based System 1500 minisupercomputer. TI holds the NuBus trademark and several patents.

Laws, a senior member of Texas Instrument's technical staff, believes that NuBus will ultimately play a role in the PC market. He predicts that even if EISA becomes the standard for personal computers using Intel Corp. microprocessors, PCs based on other chips might move to NuBus. Nowlin, who is also NuGroup's technical director, envisions a PC market evenly split between NuBus, EISA and MCA.

Maurice Klapfish, a division manager who follows the bus market for Venture Development Corp. in Natick, Mass., gives NuBus the edge because EISA remains only specifications on paper, while developing a system using MCA means paying royalties to IBM or facing the threat of lawsuits.

NuBus might even benefit from the current EISA versus MCA debate, according to Roger Storer, president of Second Wave Inc., Austin, Texas, which markets a NuBus-based expansion chassis for the Macintosh II. "NuBus is just sort of moving along independently of all that," Storer says. "It's not exactly taking off. But it is certainly growing while this EISA-Micro Channel thing is going on."

But will NuBus give Intel's Multibus II and VMEbus a run for their money? Ramunni remains skeptical, saying that many vendors of industrial systems have already committed to the VMEbus and that there are plans to improve the performance of that architecture.

Mercury Computer Systems Inc., Lowell, Mass., markets a NuBus version of its MC3200 coprocessor board for the Macintosh II. But president Jay Bertelli notes that despite gains made by the Macintosh II in industrial and manufacturing markets, NuBus is supported by no other major systems vendor. "I don't think it's going to be as good as the VME market," he says. ☐

How long can this expansion last?

The current U.S. economic expansion has entered its seventh year as of December 1988. During this phenomenal growth period, the U.S. economy has grown from just over $3 trillion to almost $5 trillion. After adjusting for inflation, the economy increased by 27%, or just over 4% per year at a compound annual rate. Such a rosy performance has many wondering, how much longer can this expansion last?

Of 54 economists surveyed in the Blue Chip Economic Indicator, Sedona, Ariz., 35% believe a recession will begin in 1989. Another 30% see the downturn arriving in 1990, and 30% see it in 1991. Compare that January 1989 poll with the poll taken 11 months earlier, when 58% expected a recession in 1989.

The upshot: Economists can't agree on when the next recession will take place. Regardless of when, 80% of those polled agree on one important feature. The recession will be less severe than in 1982, when the gross national product (GNP) dropped 2.5%.

Cahners Economics' forecast calls for GNP to rise a modest 2% in 1989 and 2.7% in 1990. That 2% forecast for 1989 is down considerably from the 3.9% growth estimated for last year. The reason growth will be sluggish: No individual sector of the U.S. economy seems primed to keep pumping at 1988's strong pace.

Relatively high interest rates will probably keep a cap on consumer spending. Concern over the federal deficit will keep government spending growing just at the rate of inflation. Factory output will be cut a bit as businesses try to cut back inventories. And export levels are not expected to increase much in 1989.

Cahners does not expect a full-fledged recession either, because no part of the economy appears ready to squeeze U.S. growth too tightly. The biggest blot on the economic horizon, and most difficult to gauge, remains the high debt levels.

Impact on electronics

Business investment in equipment will carry makers of electronics products through a sluggish 1989. After growing over 13% in 1988, equipment investment will most likely grow a slower 1.8% in 1989. Still, information processing equipment continues to gain a larger share of all those business investment purchases.

ELIZABETH B. BAATZ

Blue Chip economic consensus

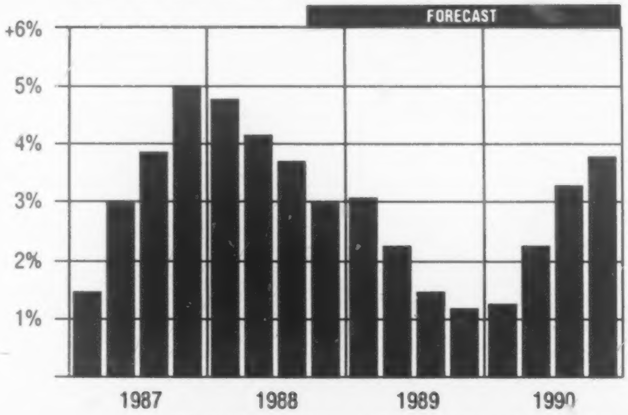
Percentage change from previous year

			FORECAST	
	1987	1988	1989	1990
Real GNP	3.4%	3.9%	2.7%	1.7%
Consumer price index	3.6%	4.3%	4.7%	4.7%
Industrial output	3.8%	5.7%	3.3%	1.7%
Disposable income	1.7%	3.3%	2.6%	1.7%
Business investment	2.8%	9.6%	4.9%	2.0%
Pretax profits	3.9%	4.9%	3.1%	1.6%

Source: Blue Chip Economic Indicators

Gross national product

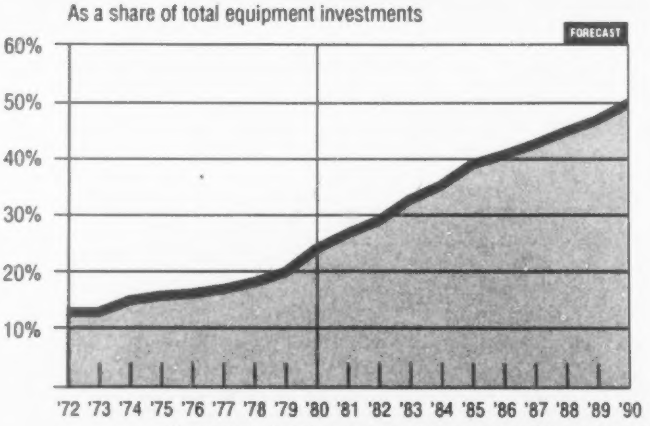
Percentage change from previous year, adjusted for inflation



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Information processing equipment investments

As a share of total equipment investments

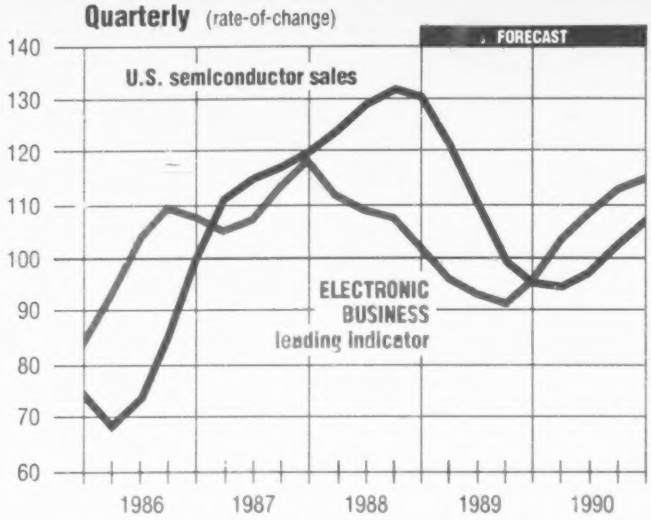


Historical data: U.S. Commerce Department; Forecast: Cahners Economics

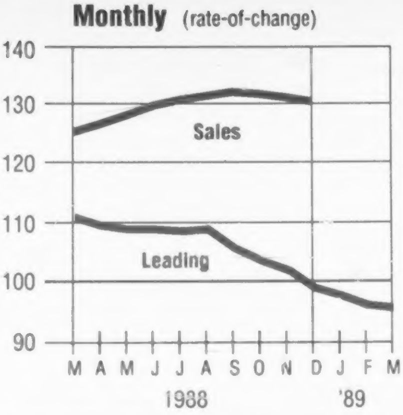
BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368



In December of 1988, the ELECTRONIC BUSINESS leading indicator fell below 100 for the first time since the beginning of 1986. The indicator is dropping at a faster rate than over the summer months, confirming that 1989 will be a weaker year.

Source: Cahners Economics

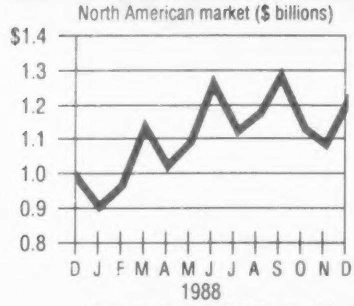
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1987 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Nov.)	101.9	103.4	117.6	111.1
U.S. semiconductor bookings ($ millions, 3-month average, Dec.)	$1,066	$1,071	$1,057	$951
Weekly hours of semiconductor production workers (monthly average, Nov.)	40.2	39.9	40.8	40.6
Electronic components leadtime index (1977 = 100, Jan.)	111.6	89.8	96.5	100.7
S&P's semiconductor stock price index (1970 =10, monthly average, Dec.)	45.8	44.2	55.8	65.5
Change in electronic components inventories ($ millions, SA, Nov.)	+$283	+$101	+$95	+$41
Contract and orders for plant and equipment ($ billions, SA, Nov.)	$39.6	$38.4	$35.4	$34.6

SA = seasonally adjusted, all other data is not seasonally adjusted

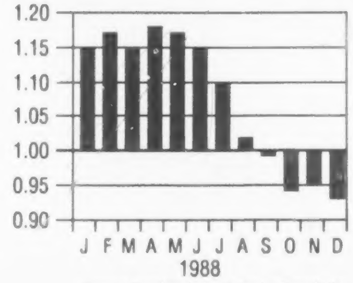
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



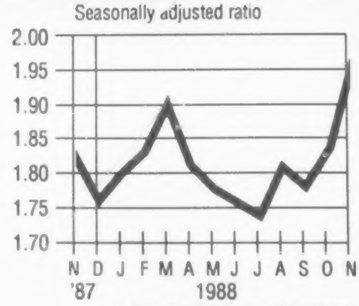
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department

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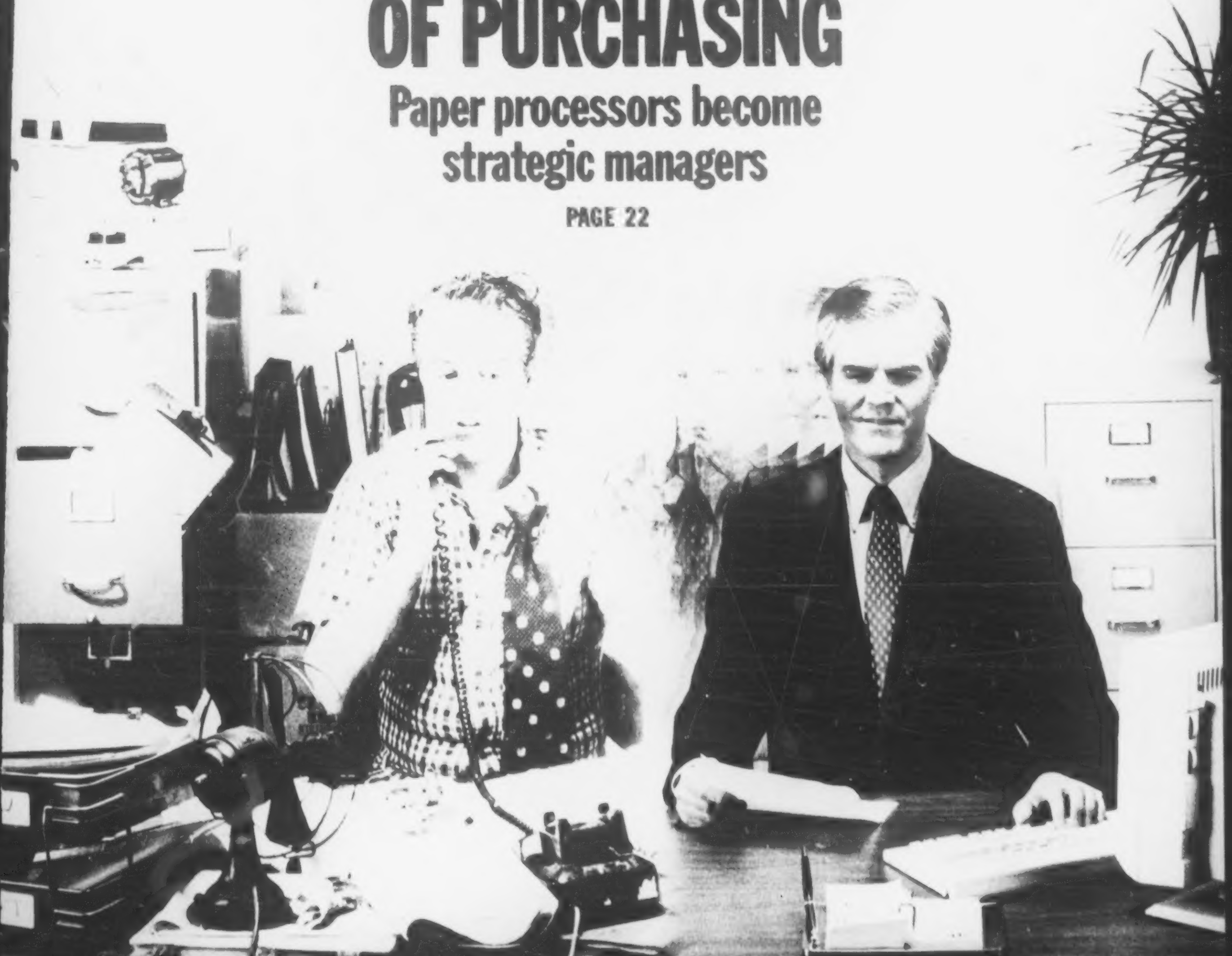
FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

MARCH 20, 1989

THE CHANGING FACE OF PURCHASING

Paper processors become strategic managers

PAGE 22



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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES — WORLDWIDE

VOL. 17, NO. 6 MARCH 20, 1989

PAGE 22 The changing face of purchasing: Paper pushers become strategic managers

COVER STORY/MANAGING RESOURCES

22 The changing face of purchasing

Earlier this year, Apple Computer admitted to a serious miscalculation. After hoarding expensive DRAMs when the market was tight, chip supplies loosened, prices fell and the personal computer maker was stuck with a stockpile of overpriced memories — a costly purchasing blunder. Apple's dilemma is not unique. A single purchasing decision can save or lose millions of dollars for a company. As a result, purchasing, long relegated to an inferior status within the corporation, is coming out of the closet.

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Visual Technologies is hoping X-Windows technology will be a savior and return it to profitability. But there's a catch. Other terminals vendors also are incorporating the technology into their products.

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AT&T's alliance with Italy's state-owned telephone equipment maker Italtel SpA has a twofold effect. It's boosting the hopes of Italy's private telecommunications vendors and positioning AT&T for post-1992 Europe.

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In a business climate where a single misguided decision can save or lose millions of dollars for a company, a new spotlight has been placed on procurement. Paper pushers are becoming strategic managers.

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HP has a top-down effort to do a better job of purchasing — from the issuance of a quality improvement challenge to a rigorous analysis of procurement practices.

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If purchasing is evolving from paper processing to a strategic management function, there is no shortage of reasons for the change.

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OEMs are starting to quantify the cost of buying cheap components, and it is changing their purchasing habits.

46 Strategic purchasing can make — or break — a firm

Mike Doyle, director of world automotive marketing operations for Motorola, tells how smart electronics managers are scrutinizing procurement policies.

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What's in a name? If your company makes supercomputers and your corporate name means "dead fish" in French, it very well may be time for a change. Last year, more than 1,800 U.S. companies changed their names.

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The era of basic research is over for Siemens as each one of its 16 new divisions has its own market-oriented R&D activities. The aim is to ensure closer contact between the research and the market it serves.

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Nurturing technologists isn't easy, but the dual ladder promotion system helps — or does it? The advice for companies going to this approach: manage it carefully.

Cover photograph: Renee Fraser; Retouch: Photo Coloratura Ltd.

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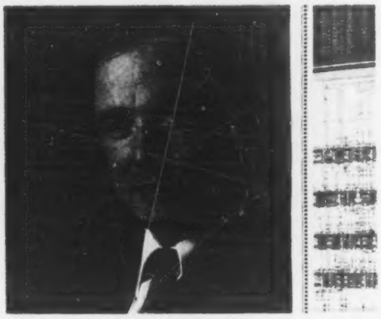

PAGE 103 Sierra's Don MacLennan: Market for mixed ASICs still promises, promises

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If you have innovators who don't want to manage, according to M.E. Hawkins and Milan Moravec, corporate human resources managers at National Semiconductor, reward them with a dual career path structure.

78 The electronics cookie jar is loaded with M&A goodies
Virtually no sector in the industry — whether hardware, software or computer services — has escaped the trend of merger and acquisition. Intensifying competition is guiding the trend.

86 Are electronics firms the last to embrace EDI?
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Here's the inside scoop on how Japan's top electronics and computer companies nickled and dimed their yen problems away.

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A year ago the promise was great for mixed-analog digital ASICs, and that promise still holds today. But there's a but: Anticipated software and test equipment have been slow to evolve.

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There's an excellent chance distributors and all other sellers of electronic products will escape a full-fledged recession altogether in 1989 and 1990.

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Purchasing: The new frontier

Purchasing has never been a glamorous profession. How many CEOs have risen from the ranks of purchasing, for example? And how often does the *Wall Street Journal* profile purchasing geniuses? Fact is, compared with marketing and finance, purchasing gets no respect. "If you get a hernia, you wind up in purchasing," goes a joke bandied about the halls of corporate America.

But a variety of factors have combined to put the spotlight on procurement. For example, between 40% and 95% of the cost of goods sold is attributed to purchased material. Thus, mistakes can be costly; indeed, purchasing errors can be disastrous. Meanwhile, global competition demands shorter product life cycle times and international sourcing. The list goes on.

Most electronics companies have been late in realizing the implications. But now, the face of purchasing is changing. Harried paper pushers are becoming sophisticated procurement strategists. Firms that once relegated purchasing to the bottom rungs of the corporate ladder are heaping status on the underrated profession. Purchasing managers are being promoted to corporate vice presidents for materials management. And corporate vice presidents for materials management are being promoted to more important positions.

Moreover, increased pressures are forcing suppliers and customers to become long-term partners. Buyers say that they are less likely to haggle over pennies and more likely to consider a variety of factors — including quality, on-time delivery, cost and responsiveness. Many firms are slashing their supplier rosters. Some favor single-sourcing many components. All these factors are combining to make sophisticated procurement policy a No. 1 concern.

Beth Karlin

Of course, not all firms are savvy enough to realize the danger of clinging to old-fashioned purchasing practices. For those that have — and perhaps more importantly for those that haven't — embraced the new religion of sophisticated purchasing, especially, we present our cover stories on the changing face of purchasing written by contributor Sylvia Tiersten and senior editor Bruce Rayner. And this is just the beginning. ELECTRONIC BUSINESS editors will follow important purchasing trends in issues to come. Next: the sometimes hostile and always changing relationship between automakers and their electronic component suppliers.

BETH KARLIN

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BPA ABP

Visual sees the light from X-Windows technology

This struggling terminals vendor is staking its future on an embryonic market — but the big boys are coming

Visual Technologies Inc. may see the light at the end of its financial tunnel — and that light is streaming in through the X-Windows market.

The vendor of text and high-end graphics terminals has been struggling in recent years since the terminals business became a rough-and-tumble commodity market. Now the Lowell, Mass., company is staking its future on a line of terminals products incorporating X-Windows technology.

Visual's dilemma and its strategy for returning to profitability are indicative of two trends in the computer industry: efforts by terminals vendors to add value to their wares and somehow distinguish themselves in the marketplace; and the growing number of vendors that are incorporating X-Windows technology into their products.

"They're all trying to get better margins, somehow," says Prudential-Bache Securities Inc. analyst Kimball Brown, speaking of terminals vendors. Between 1985 and 1992, the compound annual growth rate in units is projected at an anemic 7.2% for alphanumeric terminals and 8.8% for graphics terminals, according to Eileen O'Brien, an International Data Corp. senior analyst who follows the terminals market.

Many companies have been adding intelligence to their terminals and marketing them as diskless personal computers, while others — such as Wyse Technology — have added PCs to their product line. Visual itself made a disastrous effort to enter the personal computer arena in the mid-1980s.

"Market share and price competitiveness had become more of an issue than innovation" in the terminals business, says Visual OEM sales and marketing vice president Larry Lunetta. "The company has had some difficult times in previous years."

After Visual racked up losses of $13.5 million on sales of $21.6 million in 1986, an investment group led by Hambrecht & Quist Venture Partners assumed majority ownership and control of the company in April 1987. In the months that followed, the company's debts were restructured and its management reorganized with a number of executives departing. In 1987, Visual's sales dropped to $15 million and the company reported a loss of $7.2 million.

In early 1987, Visual identified the embryonic X-Windows market as a promising niche in which the company could leverage its technical and marketing expertise. "X-Windows was emerging as early as 1987 and was one of the few standards that was not being argued over," Lunetta says.

Developed at the Massachusetts Institute of Technology, X-Windows has been endorsed as a standard by nearly every major computer vendor. A windowing system allows a computer screen to simultaneously display multiple applications, and X-Windows extends that capability to a multivendor network. The system's graphics and communications protocols provide software developers with a standards-based foundation upon which they can build applications.

Visual unveiled the 640 X Display Station last August and touts the product as offering the ease of use of a terminal combined with the functionality of a workstation. Built into the product is the server or display portion of X-Windows Version 11, which allows the terminal to access over a network the client or host portion of X-Windows implemented on a computer. The 640 XDS, which is based on Visual's older Series 600 terminal and uses the Motorola 68000 chip, offers a monochrome bit-mapped 1,024-pixel by 800-pixel resolution display and Ethernet networking capability.

Visual worked with XPI Inc., a Providence, Rhode Island-based developer of X-Windows software and networking technology, to design the 640 XDS terminal. However, outside of MIT and Digital Equipment Corp., XPI was the first company to incorporate the X-Windows system into its networking and software

John Kennard

Visual Technologies' OEM sales and marketing vice president Larry Lunetta: Moving into the X-Windows market, the firm's attitude now is that of a start-up

products. Last November, Visual acquired the privately held XPI for an undisclosed sum and named XPI president Brian Chapin to the post of advanced marketing and technology vice president.

Visual has been shipping the 640 XDS in volume since September, and by January had over 500 units installed with order backlogs of 30 to 60 days, according to Lunetta. The terminal, priced at $1,995, is manufactured for Visual by Oriental Precision Co. Ltd. in Korea.

Visual is selling the product through computer manufacturers, OEMs, large-volume VARs and what Lunetta describes as "sophisticated end users" who integrate their own systems. Target markets for the 640 XDS include text and graphics applications in desktop publishing, financial systems, software engineering and factory automation. CAD/CAM will also become a target market later this year when Visual unveils a color version of the product.

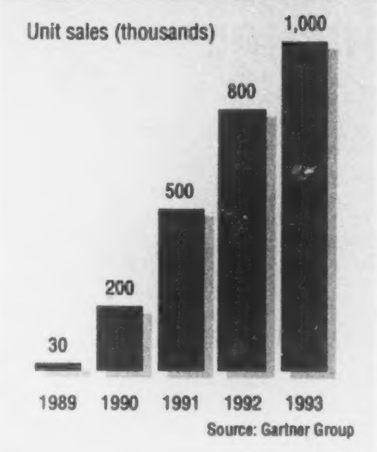
Allies in the X-Windows world

Last December, Visual inked a multiyear OEM distribution deal with Kubota Computer Inc. of Japan valued at $2 million in the first year. Vendors that have developed interfaces to Visual's terminal-based server include Applix Inc., Westborough, Mass.; Cimlinc Inc., Elk Grove, Ill.; Frame Technology Corp., San Jose; Oracle Corp. of Belmont, Calif.; and Sequent Computer Systems Inc. of Beaverton, Ore. Visual has also signed an agreement with Sorbus Inc. to service the 640 XDS.

Visual plans to broaden its product line using the XPI technology. Although the company continues to sell standard terminals, they are expected to account for only 50% of Visual's sales this year and an increasingly smaller percentage of its business in the future, according to Lunetta. "I think it's fair to say that Visual is moving out of the terminals business and moving into the X-Windows market," he says.

In fiscal 1988, ended September 30, Visual reported a loss of $6.2 million on sales of $8.5 million. Meanwhile, the company is striving for sales of $18 million this fiscal year and is hopeful of breaking even or turning a small profit. "We have an organizational attitude that is as much a start-up as anything else," Lunetta says of the atmosphere at Visual.

X-Windows display stations



Source: Gartner Group

While IDC's O'Brien foresees potential within the X-Windows market, she believes it will be three to five years before it really catches on. "People are not going to just dump their [standard] terminals overnight," she says. "The X-Windows market is really in its infancy." Dataquest Inc. senior industry analyst Robert Cameron also believes that demand for terminals incorporating X-Windows technology is several years away. "I believe we're talking 1995," he says.

The entrance by large vendors could add legitimacy to the market and fuel its growth

The Gartner Group research firm in Stamford, Conn., is projecting that worldwide unit volume sales of X-Windows display stations (terminals, diskless personal computers and workstations) will reach 30,000 units this year and increase to 200,000 units in 1990; 500,000 units in 1991; 800,000 units in 1992; and 1 million units in 1993. Gartner Group vice president Craig Symons states that the average price of a display station will be $2,500 this year and will drop by approximately 30% to 40% each year.

"The real issue is whether users will adopt this technology," Symons says. He believes that may happen as part of a backlash against the increasing complexity of personal computers and their attendant software and networking technology. X-Windows display stations, he says, will offer the same functionality as a PC or workstation while leaving the complex backup, troubleshooting and other chores to a central computer system.

But will they sell?

"I think that Visual, in general, is one step ahead of the crowd," says IDC's O'Brien. Other terminal vendors now entering the X-Windows market include Acer Counterpoint Inc. of San Jose, which markets the Xebra Model 100 terminal for low-end X-Windows applications; and Tektronix Inc. of Beaverton, Ore., which recently unveiled the 4211 Graphics Netstation; and Network Computing Devices Inc. of Mountain View, Calif.

But a potential curse — or blessing — for vendors like Visual is the expected debut of competing products from big vendors. Digital in particular is heavily promoting its DECwindows technology based on the X-Windows system. The entrance by large vendors could add legitimacy to the market and fuel its growth, analysts say, but smaller vendors could find themselves crushed by the bigger companies.

DEC is adding DECwindows functionality to its operating systems and to all its workstation and personal computer systems. However, Cameron says he believes that DEC will debut a DECwindows server terminal inside of 18 months. Currently, DEC is pushing its independent software vendor allies to adapt their products to DECwindows specifications.

Prudential-Bache's Brown believes that Visual will face severe competition from DEC and other major vendors when they begin marketing terminals with X-Windows technology. He says Visual may be able to compete on a technology basis by offering a better product, but that lower prices alone will not be enough to compete with the big vendors.

RICK WHITING

AT&T-Italtel combo may aid private telecom growth

In addition to raising Italy's private telecom vendors' hopes, AT&T is boosting its own position in Europe, anticipating 1992

Will the alliance of AT&T with Italy's state-owned telephone equipment maker Italtel SpA give the Italian private telecommunications market the shake-up it needs?

Italy is the third country in which AT&T has initiated a joint venture with the "national champion." Combined with similar ventures in Holland and Spain, the new Italian deal should offer AT&T an excellent market position when the next generation of telecommunications products is developed. When customs borders cease to exist in post-1992 Europe, AT&T should already be poised to offer pan-European products.

AT&T will work with Italtel in fulfilling a $30 billion plan to improve the Italian public network. AT&T is eager to get a share of this investment, and should become a close collaborator with the Italian public telecom system.

Operators are hoping that AT&T's work with the public provider will give the private telecom market a much-needed boost. The backward state of Italy's public telecom network, combined with overregulation, is suffocating the Italian market for private telecom products.

"It's a strange, typically Italian paradox," says Franco Morganti, a telecommunications analyst at the Milan-based Technibank SpA. "In some areas of our country, information technology is in a very advanced state. But the laws governing telecommunications are backward and the public telecommunications network with reasonable tariffs doesn't exist. It's the same with all of our monopolized public services."

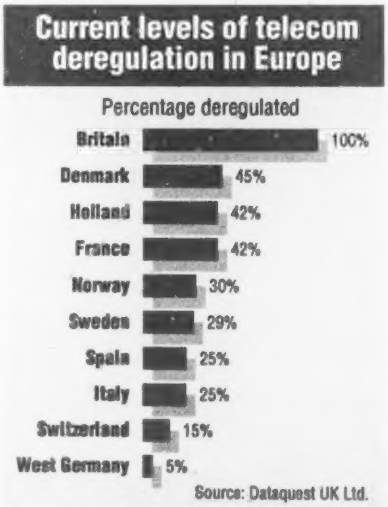
"AT&T is a manufacturer and a carrier," he adds. "We hope its vast experience will be used to help our troubled public system."

Analysts hesitate to estimate the potential market for private telecom, given the huge disparity in size and sophistication among the different kinds of equipment that are in use. However, the London-based consulting firm Dataquest UK Ltd. estimates that the current Italian market for end-user products is about $1.12 billion. But analysts say the potential is much greater.

"The market is impoverished," says Giovanni Lizzieri, of another Milan consulting firm, Reseau SRL. "The qualitative and quantitative structural flaws in the public [networks] have strangled the Italian market in private networks and in value-added services. This means that vendors of telecommunications technology have a sickly, starved market, even though the market for these products is healthy enough in most other countries."

Franco Boscu, director of private telecom for Siemens Italia SpA, agrees. "Sometimes our projects get held up because we become involved in long negotiations with the SIP [the Italian phone company] about who handles which interface between the private network and the public," he says. Despite the respectable number of Italian computers, he says, "we construct only four or five major private networks a year."

The Italian private-network builder has only three ways to connect the various parts of his network. He can use the public telephone service, but this means exposing his operation to the risks inherent in a principally electromechanical network that already has more traffic than it can handle. Or he can use the "Fonia-Dati" network for data transmission which has very high quality — but also high cost. Or he can use the Italian public X.25 packet switching network "ITAPAC," which is run by the SIP and the Ministry for the Post, which has relatively few modes of access and is also rather expensive. "The result is that we don't sell many new private networks, we only improve the [approximately 2,000] ones that already exist," explains IBM telecom director Renzo Botazzi.



Current levels of telecom deregulation in Europe

Source: Dataquest UK Ltd.

Another factor that brings up the cost of constructing a private network in Italy is the incoherent tariff policy used for the obligatory rental of lines. "There are too many different laws that govern tariffs, and the resulting tangle makes the business unnecessarily complex," complains Bull HN Italia SpA marketing director Giacomo Zanone. "Because of the special measures adopted to develop the south of Italy, it costs less to rent a line from Milan to Palermo than from Milan to Florence." Palermo is more than twice as far from Milan as Florence.

Since the network market in Italy is so small, the services available for such networks are also very limited. "The Italian market for value-added networking services is also overregulated," continues Reseau analyst Lizzieri. "General Electric Information Services Italia SpA controls the lion's share of the market, about 41%, and most of their clients are the few, large corporations that we have."

A proposed law under consideration by the Italian parliament would make selling and operating private networks a lot easier. But operators are skeptical about the law's ever making its way through the Byzantine network of Italian politics.

All the companies that operate in the area of private telecom are looking forward to the deregulation that is expected in 1992. Says Ing. C. Olivetti & Co. SpA information systems specialist Giacomo Repetto, "Once it becomes easier for computers to communicate, there will be a lot more communicating."

ANDY ROSENBAUM

The electronics cookie jar is loaded with M&A goodies

Virtually no sector in the industry — whether hardware, software or computer services — has escaped the trend of merger and acquisition

BY RAY WISE

Merger and acquisition activity has hit a new high in electronics, powered by intensifying competition in the industry, technological change and a snobbish market for initial public offerings.

There were a record 594 mergers and acquisitions of hardware, software and computer services companies in 1988, 19% more than the 499 recorded a year earlier, and hardware companies alone accounted for 160 deals, compared with 141 in 1987, according to George Grodahl, partner in the San Francisco office of Broadview Associates. The investment banking firm headquartered in Fort Lee, N.J., specializes in M&A in the information technology field and tracks these deals closely.

"There is an extremely high level of M&A activity in technology these days," says George Von Gehr, partner in Vol & Covington and M&A boss for the San Francisco-based investment banking house. Hambrecht & Quist, in the same city, concurs. "The volume of activity is up strongly," reports Jim Timmins, a partner in H&Q's investment banking division.

The new M&A department of Advent International, venture capital firm in Boston, already is busily engaged in deal making. "We currently are working on five deals, and we haven't started marketing. We don't even have a brochure to tell people what we do. Once we begin advertising, we'll have more work than we can handle," says Steve Kahn, director, mergers and acquisitions.

Many of the M&A deals being cut these days are valued under $25 million. "The buyers are either large, public companies or 'privates' in the $50 million to $200 million annual sales range acquiring smaller brethren that are struggling in one way or another," says Timmins. "I can think of no sector in electronics that has escaped the M&A uptrend. Hardware, software, defense electronics, telecommunications. You name it."

Foreign buyers abound

Encouraged by the appreciation of their currencies against the dollar, foreign buyers abound, picking and choosing from the wide array of technologies available in the U.S. and paying discount prices. "It's like dipping into a cookie jar," says Von Gehr. "If you're a German or Japanese or Taiwanese company, it's hard to put together an infrastructure in the U.S. Some surprisingly large overseas outfits do not have substantial infrastructures in this country."

1988's top 5 deals in electronics and computers

Top M&As in terms of dollars from one or both sides of the hardware, software or computer services industry. Covers companies acquired in the U.S. only

1. Nippon Mining Co. acquires Gould for $1.1 billion.
   Status: Completed; **Type:** Friendly
2. MAI Basic Four offers $970 million for Prime Computer.
   Status: Pending; **Type:** Hostile
3. Memorex International acquires Telex for $922 million.
   Status: Completed; **Type:** Friendly
4. Prime Computer acquires Computervision for $457 million.
   Status: Completed; **Type:** Hostile
5. Unisys offers $332 million for Convergent Technologies.
   Status: Pending; **Type:** Friendly

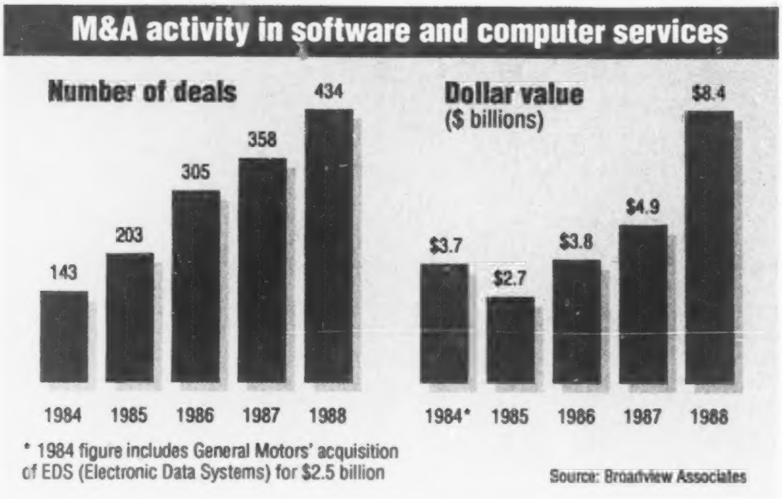
Source: Hambrecht & Quist Inc.

The high volume of M&A deals also reflects conditions in the U.S. electronics industry. Nourished by a greatly expanded venture capital industry, hordes of companies have streamed into electronics in recent years, making consolidation inevitable. "There is a lot of consolidation going on, a lot of heavy competitive crowding in the computer industry, and a lot of acquisitions for survival," notes Dorothy Langer, vice president of 3i Ventures, Boston.

"There is going to be a lot more consolidation, especially in software," Langer predicts, stressing that most relatively new, highly profitable businesses attract an army of new entrants that must be shaken out eventually. Moreover, some sectors of electronics have experienced disappointing growth rates recently, further fueling the trend toward protective mergers and acquisitions. Acquirers simply are buying out the competition, or bolstering themselves through diversification or by absorbing smaller ventures that offer strategic "fits" with their own product lines.

The strategic acquisitions usually result from "buy rather than make" decisions. "Companies are finding that developing new products is expensive, time-consuming and risky, and that it is cheaper, faster and safer to buy a proven capability," says Grodahl. The larger outfits seem to be less effective at doing R&D; entrepreneurs, on the other hand, have a way of rolling their sleeves up and getting it done. For these and other reasons, Grodahl adds, "there are more acquirers out there today than ever before."

Apple Computer Inc. has been an acquirer from time to time, as a means to an end, says Jane A. Risser, manager of investor relations. "The end is to continue to innovate, in



M&A activity in software and computer services

* 1984 figure includes General Motors' acquisition of EDS (Electronic Data Systems) for $2.5 billion

Source: Broadview Associates

hardware and software, to increase the productivity of the desktop computer. In the past, the acquired companies have been in software."

Industry standards

Industry standards are another catalyst for M&A activity, according to Langer. "The hardware manufacturers are going to Unix, and they all need third-party, applications software. They can't write it themselves."

Philip Barton, who runs the Fidelity Select Software and Computer Services Portfolio, Boston, points out that while small companies can be excellent vehicles for technological innovation, they often need partners. Moreover, he says, partnering is being nurtured these days by technological progress and product upgrading. The PC-workstation cycle is kicking into high gear, fostering advances in chip technology, processor logic and operating system software and, in the process, has created a window for entrepreneurs. Some of them, fearing they will miss out on the technological wave if they delay participation long enough to grow on their own, are scrambling for partners instead, Barton reports.

Moreover, the new chip technologies are proving a headache to those innovative IC designers who use the fabrication lines of others — the so-called "fabless wonders" — that find it is becoming increasingly necessary to have a line of one's own. To build one requires a partner having pockets that are about $100 million deep.

As the acquirers must face an increasingly competitive marketplace, so must their smaller counterparts. Being acquired can inject cash into an enterprise, furnish distribution channels for its products and increase critical mass enough to make the merged company stand out in the crowd and display viability to its customers and prospects. "Entrepreneurs inevitably are asked, "will you be around to take care of me if I buy your product? Can you support me on a global scale?' " says Grodahl. Some entrepreneurs fear the U.S. will undergo a recession in a year or so, and Von Gehr notes that a "recession heightens the need for cash and for distribution channels." A recession by 1990, accompanied by rising interest rates and debt service costs and a profit-suppressing tax increase is the forecast of Richard M. Rodnick, chairman of Geneva Co., financial services firm based in Irvine, Calif. Rodnick figures that an economic slowdown would end the M&A boom and so, he says, entrepreneurs wanting to sell out should consider doing so over the next few months while prices are still favorable.

The high volume of M&A deals reflects conditions in the electronics industry

Meanwhile, the IPO market has become so severely selective that most small electronics companies no longer can count on it as a source of capital. "The IPO route is a real gamble. People don't want to put up the money to allow these companies to grow independently," says Christian F. Horn, president of Grace Ventures, Cupertino, Calif. Barton points out that only well-established companies having solid track records in revenue and earnings and rated highly by their customers have a prayer of going public. The market still is replete with undervalued high-tech shares, especially in the data storage, chip and chip-making equipment sectors. "A lot of the market's behavior is emotional," according to Timmins. "Most of the companies are doing well, but they can report earnings and revenue gains of 50% to 100% and get absolutely no reaction from the market. The shares don't move."

Given the condition of the IPO market, entrepreneurs often can make a better deal through M&A and, in addition, the acquirer usually must pay a "control premium" for taking over the enterprise, notes Katherine R. Kirk, a partner in the Boston office of Hambrecht & Quist.

Selling a company can be like selling a dream, but Barton points out that some deals are structured to allow the entrepreneur to keep his or her hand in the venture for a time and profit by its success. The purchase price in an "earn out" consists of a straight distribution of cash and stock in the acquiring company, plus a deferred incentive bonus that is paid if the acquired operation meets certain financial objectives. "About 25% to 30% of M&A transactions are earn-outs," according to Grodahl.

Historically, venture capitalists have kept their portfolio companies going in bad IPO markets, but they aren't so quick to reach for their checkbooks these days. Horn says some are grappling with problem companies that already are in their portfolios. Others are passing up new ventures in favor of going into the stock market and buying up undervalued technology shares, Timmins reports.

"Companies are finding that they don't have financing alternatives to M&A," according to the investment banker. ☐

How Japan overcame the high-valued yen

Here's the inside scoop on how Japan's top electronics and computer companies nickled and dimed their yen problems away

BY PAULA DOE

What would you do if the dollar suddenly appreciated by more than 70%, making your products that much more expensive in overseas markets? For export-oriented Japan Inc., which saw the yen appreciate by 77% over a three-year period, the question was not hypothetical. Indeed, because of the highly appreciated currency, the average pretax earnings per employee for Japan's 29 largest publicly held electronics companies plummeted from $26,700 in 1985 to less than $12,000 just two years later.

However, Japan has spent little time wallowing in self pity. On the contrary, the major electronics companies there have been busy holding overseas prices in check by whittling down costs at every corner. In typical Japanese fashion, drastic measures such as massive layoffs were avoided in favor of yen-pinching approaches involving the finetuning of existing operations. The subtler strategy appears to have paid off. The operating income of Japan's top 29 electronics companies surged 73.9% to $5.8 billion in fiscal 1988, ended last March.

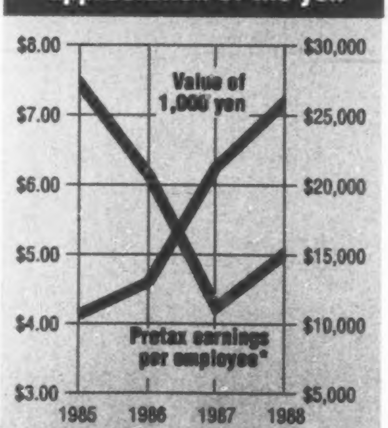
ELECTRONIC BUSINESS tracks the leading Japanese electronics companies using detailed financial reports *(Yuka Shoken Hokoku)* published by Japan's Ministry of Finance and the exhaustive compilation of industry statistics *(Shuyo Kigyo Keiei Bunseki)* put out by the Bank of Japan. Figures from the company reports are also available in the annual *Kaisha Nenkan*, published by *Nihon Keizai Shimbun*.

All these Japanese-language sources offer much more detail than the annual reports available in English, specifying everything from how much a company spent on advertising to how much it spent on capital equipment at each of its plants.

Exactly how did the Japanese manage to ground the high-flying yen? At Fujitsu Ltd., personnel costs were cut 13% and manufacturing overhead reduced by 5% in fiscal 1988, a year in which sales grew by 16%. Revenue at Hitachi Ltd. remained flat, but the company spent 3% less on materials. Indeed, much of last year's big recovery at Japan's major electronics companies came from squeezing out additional small-scale improvements in already lean manufacturing operations.

Trimming manufacturing costs by a few percentage points was enough to get operating margins at Japan's major electronics companies back up to 3% to 4% of revenue for fiscal 1988, a marked improvement from 1% to 2% the year before. That may not sound like anything to write home about, but even in the heady days of 1984, operating margins for the Japanese sector as a whole were only 6.7%.

The Japanese begin to recover from the rapid appreciation of the yen



Figures are for the fiscal year ending in March.
* For Japan's 29 largest publicly held electronics companies. Figures are converted at a constant ¥125 = $1, for convenience purposes only.

Sources: Bank of Japan, Federal Reserve Bank of New York

Forget the massive layoffs

Even in the face of the high yen, the major Japanese companies have not resorted to draconian measures like massive layoffs or major corporate restructurings. Despite the flight of production offshore, the parent Japanese companies have not appreciably cut back on domestic employment. The total number of permanent employees for all 29 parent companies in the sector tracked by the Bank of Japan actually went up about 2% last fiscal year, while each of the five largest companies cut staff by a mere 0.5% to 2%.

Nor did the big Japanese electronics makers cut back on their selling, general and administrative expenses. These costs went up 10% for the sector, increasing a consistent 10% to 14% at all the big companies, which equaled or surpassed revenue growth in all cases. Companies also kept up their research and marketing spending. Not surprisingly, they could do little to trim such costs as utilities, taxes and depreciation. Many of the companies did, however, trim their administrative staff costs, presumably, in part, by cutting bonuses. SG&A personnel costs for the sector as a whole were down 3%, to a mere 3% of total sales. In particular, Fujitsu cut its support personnel costs by a whopping 35%.

What the Japanese companies did was to squeeze a few more percentage points out of their already lean product costs, and each company found a different place for improvements. For the sector as a whole, the biggest improvements came in product costs other than manufacturing, which essentially means outside purchases. While sales climbed 6% for the sector as a whole and manufacturing costs increased 5%, product costs other than manufacturing climbed only 3.5%.

At Matsushita Electric Industrial Co. Ltd., sales were up 3% and manufacturing costs up 8%. But nonmanufacturing product costs increased only 2% — which accounted for most of the company's improved operating margins. In other words, Matsushita paid proportionally less for the products it purchased outside. This achievement was thanks to Matsushita's numerous suppliers, including the company's own subsidiaries and affiliates, which scrambled to set up low-cost production facilities abroad. By moving offshore, the Japanese transformed their high-valued yen, with its mighty international purchasing power, from a crippling handicap to a significant advantage.

Don't cry for me Tokyo

The brawny yen also helped the Japanese keep materials costs down, as many companies began to buy more parts from offshore sources. Indeed, materials costs were the next biggest area of savings, going up only 4% to support a 6% increase in sales for the Japanese electronics sector as a whole. Hitachi made its biggest cuts in materials costs, trimming them by 3% while maintaining virtually the same volume of sales as the year before. Toshiba Corp. similarly squeezed out a tiny cut in materials costs, while supporting a 7.2% increase in sales volume.

Raw material inventory turnover for Japan's electronics sector averaged 74 times for fiscal 1988, a 3% improvement from the year before. Total inventories, including purchased goods and finished goods, came to 74% of average monthly sales, while the companies turned over their total inventories an average 10 times, 4% better than the year before.

For the Japanese electronics industry, manufacturing overhead expenses outpaced growth in sales volume. Fujitsu, however, cut its costs primarily by trimming its manufacturing overhead, achieving nearly 5% savings even though sales volume was up approximately 16%.

Ray Medici

Manufacturing labor costs increased slightly at most companies, but not as sharply as sales. NEC Corp., in fact, improved its operating margins by holding manufacturing labor costs at fiscal 1986 levels, while achieving an 8% increase in sales volume.

The major Japanese companies also managed to squeeze out modest increases in worker output. Sales per employee for the electronics sector as a whole were up 4%, with rates at the major companies ranging from 4% to 15%. Value added from operations per employee increased 7% for the sector and 2% to 12% at the major companies.

Obviously, because of the high-valued yen, the Japanese can't boast cheap labor costs anymore. The leading electronics companies are paying an average salary, including benefits, of $44,700 a worker, up 18% in dollar terms over the last year. With personnel costs still averaging 13% of sales, that hurts.

Nor are the Japanese companies significantly more globally oriented than the U.S. sector anymore. Exports for the Japanese sector as a whole averaged 30%, while Fujitsu, Hitachi and NEC got less than 30% of their total consolidated worldwide sales abroad. Overseas sales for the ELECTRONIC BUSINESS 200 averaged 25% of total revenue in 1987. And many major U.S. companies, including IBM, Digital Equipment Corp., Unisys Corp., Xerox Corp., Hewlett-Packard Co. and Motorola Inc., to name just a few, had foreign sales reaching 40% to 50% of total revenue.

Shattering a myth

Debt levels at the Japanese companies are not as high as myth would have it. Debt runs 33% of total capital for the sector overall, compared with 28% for the ELECTRONIC BUSINESS 200. Some of the more highly leveraged companies, such as NEC, carry debt that reaches 66% of its total capital, well above the U.S. average, but certainly not out of the range of some big U.S. electronics makers. Lockheed Corp., Singer Co., Emerson Radio Corp., Contel, and United Telecommunications Inc. all similarly have debt comprising over 60% of their total capital. In fact, debt levels at 30% to 50% of total capital are common in the United States.

One area in which the Japanese did little scrimping was in R&D. For the major electronics companies in Japan, R&D expenses totaled 6% to 16% of revenue last fiscal year, up 4% to 16% from the year before. The average for the Japanese electronics sector as a whole was something less than 7% of sales, although the Bank of Japan does not collect exact figures. For the top 20 U.S. electronics companies, R&D spending averaged 7.5% of sales during roughly the same time period. □

How the Japanese recovered from the high-valued yen

	Japanese electronics sector	Change	**Fujitsu**	Change	**Hitachi**	Change	**Matsushita**	Change*	**NEC**	Change	**Toshiba**	Change
Fiscal 1988 sales ($ billions)	$174.7	+6.2%	$13.7	+15.7%	$23.4	-0.2%	$26.2	+3.4%	$18.4	+8.5%	$21.5	+7.2%
Relative costs (as percentage of total sales)												
Cost of sales	**76.7%**	**+3.5%**	**63.6%**	**+12.9%**	**76.8%**	**-4.4%**	**80.9%**	**+1.9%**	**69.2%**	**+6.8%**	**75.2%**	**+2.7%**
Cost of manufacturing	58.3%	+4.9%	56.0%	+10.6%	76.7%	-1.4%	24.9%	+8.7%	55.8%	+7.2%	53.9%	-1.8%
Materials	39.4%	+4.3%	44.1%	+11.5%	41.9%	-3.0%	19.1%	+11.6%	46.6%	+6.3%	35.7%	-0.2%
Labor	9.6%	+5.2%	7.9%	+5.8%	14.0%	+1.3%	3.9%	+4.0%	7.4%	+0.3%	10.9%	+3.7%
Overhead	11.9%	+9.5%	5.5%	-4.6%	20.6%	-1.4%	2.9%	+3.9%	17.8%	+14.0%	7.9%	-0.4%
Account transfers	-2.6%	—	-1.5%	—	-0.2%	—	-1.0%	—	-16.0%	—	-0.6%	—
Selling, general, and administrative costs	**20.0%**	**+10.1%**	**32.4%**	**+14.2%**	**18.9%**	**+11.4%**	**16.7%**	**+11.5%**	**27.0%**	**+10.4%**	**21.8%**	**+12.2%**
Personnel	3.3%	-2.9%	4.0%	-35.4%	2.3%	+3.9%	3.9%	+0.0%	2.8%	+14.2%	3.3%	+9.3%
Operating income	**3.3%**	**+73.9%**	**4.0%**	**+131.0%**	**4.3%**	**+40.2%**	**2.3%**	**+3.2%**	**3.8%**	**+30.6%**	**3.0%**	**+119.6%**
Estimated value from operations (as percentage of total sales)												
Value added from operations	**21.0%**	**+9.1%**	**22.6%**	**+2.7%**	**25.8%**	**+6.4%**	**12.6%**	**NA**	**19.8%**	**+10.7%**	**22.6%**	**+9.4%**
Expenses other than outside purchases:												
Personnel expense	12.9%	-3.0%	11.8%	-12.9%	16.3%	+1.6%	7.8%	NA	10.2%	+3.7%	14.2%	+4.9%
Rents & leases	0.1%	-48.3%	0.4%	-9.0%	0.3%	+3.8%		NA	1.4%	+10.9%	0.1%	-69.6%
Depreciation	4.2%	-0.6%	5.8%	-5.0%	4.1%	-10.5%	1.5%	NA	3.8%	+9.5%	5.3%	-0.5%
Taxes charged as operating expense	0.5%	+34.3%	0.6%	+165.4%	0.8%	+79.8%	0.9%	NA	0.6%	+48.2%	0.0%	+0.0%
Use of labor (dollar figures in thousands)												
Number of employees	503,411	+1.9%	50,067	-0.5%	76,210	-2.3%	39,707	-0.9%	38,004	-0.9%	70,288	-0.6%
Personnel expense/employee	$44.7	+17.9%**	$32.1	+1.3%**	$50.0	+21.7%**	$51.3	+19.9%**	$49.7	+22.4%**	$43.4	+23.3%**
Manufacturing labor expense/SG&A personnel expense	2.91	+8.4%	1.97	+64.1%	6.18	-2.4%	1.02	NM	2.65	+12.4%	3.31	+5.0%
Sales/employee	$347.0	+4.3%	$271.0	+15.1%	$306.5	+7.9%	$660.3	+4.4%	$485.1	+9.5%	$305.3	+7.8%
Operating income/employee	$11.2	+70.8%	$10.8	+130.9%	$13.3	+52.7%	$15.4	+4.2%	$18.3	+31.9%	$9.1	+121.0%
Value added/employee	$72.9	+7.1%	$61.2	+2.2%	$79.0	+8.9%	$83.0	NM	$96.3	+11.8%	$69.2	+10.0%
Value added/dollar pesonnel expense	1.63	+6.5%	1.91	+17.5%	1.58	+4.6%	1.62	NM	1.94	+6.6%	1.59	+3.9%
Use of capital (dollar figures in thousands)												
Investment/employee	$199.5	+11.0%	$190.6	+10.4%	$161.9	+8.8%	$385.1	+19.8%	$247.6	+2.3%	$134.4	+11.9%
Value added/dollar investment	0.40	+5.4%	0.32	-1.7%	0.49	+0.0%	0.22	+0.0%	0.39	+9.3%	0.52	-1.7%
Return on equity	5%	—	5%	—	7%	—	7%	—	4%	—	8%	—
Return on investment	4%	—	3%	—	4%	—	5%	—	2%	—	3%	—

All figures are for the fiscal year ending March 1988

Conversion rate: ¥125 = $1 NA = not available NM = not meaningful

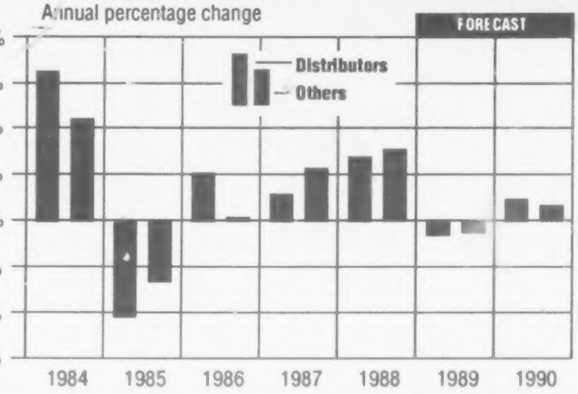
*Changes for Matsushita are figured from the company's last full fiscal year, which ended November 1986

**Change in personnel expense per employee is figured in dollars

Percent change refers to the change in yen-based figures from March 1967 to March 1988, unless otherwise noted

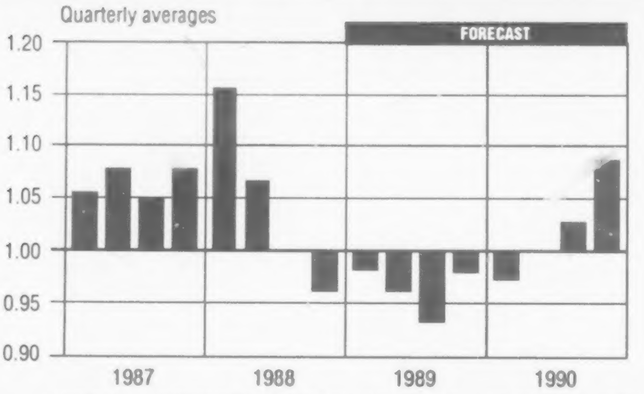
Sources: The composite figures for Japan's electronics sector are for the 29 largest publicly held electronics companies (unconsolidated), compiled in the Bank of Japan's annual analysis of Japanese industry. Individual company figures are for the parent company only, from company reports published by Japan's Ministry of Finance.

U.S. semiconductor sales growth



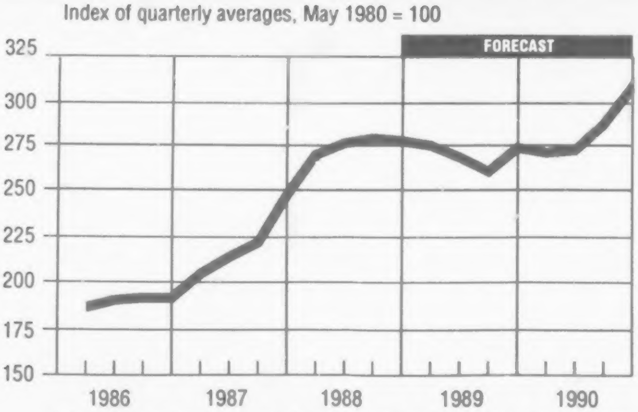
Historical data: Semiconductor Industry Association; Forecast: Cahners Economics

Distributors' book-to-bill ratio



Historical data: National Electronic Distributors Association; Forecast: Cahners Economics

Distributors' shipments index



Historical data: National Electronic Distributors Association; Forecast: Cahners Economics

Distributors dodging recession in 1989

When the economy slows down, everyone becomes afraid of the big bad wolf — recession. One group in the electronics industry has even more to fear from the recessionary wolf — distributors.

History has proven that when electronics sales fall, sales by distributors fall further. It makes sense, because when sales are booming and supplies become harder to obtain, more buyers turn to distributors in order to ensure reliable deliveries of the components they need. Meanwhile, that old maxim of business life still applies. What goes up must come down.

1984 and 1985 were classic examples of the extra volatility that distributor sales tend to experience. Distributors' semiconductor sales in North America surged 65% in 1984 and plummeted 41% in 1985 according to Semiconductor Industry Association surveys. During the same two-year boom-bust period, sales of semiconductors that did not pass through the distributor chain rose 45% and fell only 27%.

What's ahead for distributors?

Cahners Economics' forecast for total U.S. semiconductor sales calls for a 5% decline this year. Does that mean distributors of semiconductors should expect an even steeper drop? No, not this time. Last year, sales through distributors rose nearly 30% and other sales rose nearly 32%. Unlike past years, distributors' sales growth in 1988 nearly matched that of the rest of the industry.

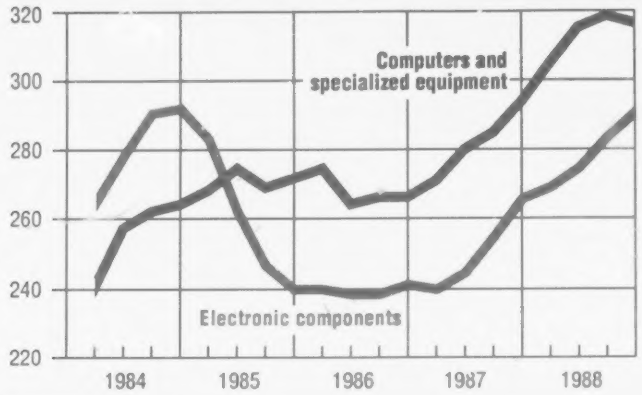
And, unlike in 1984, supplies of most types of components were fairly easy to obtain. So the economic incentive to buy through distributors was not as strong in 1988 as it was in 1984. Indeed, distributors captured 25.3% of all semiconductor sales in 1984 and only 22.6% in 1988. While such a story was a disappointing one for distributors last year, the bonus this year is that sales through distributors will remain relatively stable.

Best of all, there's an excellent chance distributors and all other sellers of electronic products will escape a full-fledged recession altogether in 1989 and 1990. End-market demand will be weaker in 1989, compared with last year, but demand will not crumble completely. The most significant implication of this forecast is that distributors will face ever greater pressures to be more competitive both with price and service this year.

ELIZABETH BAATZ

Components versus computer production

Index of quarterly averages, 1977 = 100, seasonally adjusted

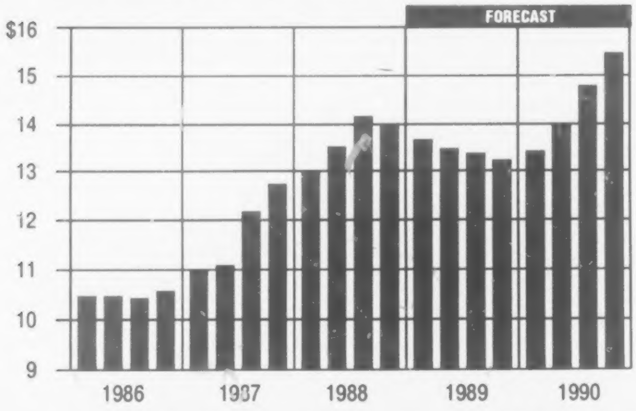


Components: SIC 367
Computers: SIC 357-9

Historical data: Federal Reserve Board; Forecast: Cahners Economics

Electronic components shipments

Quarterly averages, seasonally adjusted ($ billions)



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

U.S. component imports/Apparent consumption

Percentage	1984	1985	1986	1987
Capacitors	22%	24%	30%	35%
Connectors	5%	4%	12%	10%
Integrated circuits	24%	28%	33%	36%
Printed circuit boards	8%	10%	13%	14%
Resistors	38%	24%	25%	33%

Apparent consumption is derived by subtracting the estimated producers' price of export from the sum of manufacturers' shipments and imports for consumption

Source: U.S. Bureau of the Census

Counting components in the United States

U.S. producers of electronic components did well in 1988 — so well they have nearly made up for the losses suffered during the last recession. According to the Federal Reserve Board's survey of domestic factories, output by November 1988 was only half a percentage point short of 1984's record breaking production levels.

Still, there's one problem with that half a percent shortfall. It's short. Why haven't U.S. component makers blasted past records? Take a look at the major component end markets. The computer and specialized equipment industry broke its 1985 record by 13.5%. Test and control instruments output raced ahead of 1986 records by 17.7%. Even U.S. production of motor vehicles and parts surged above 1985 factory records by 2%. Only communication equipment lost more ground than components, but then only 1.7% below 1985 records. The question remains, why haven't the production figures for components kept pace?

Statistical quicksand

One reason factory production of components fails in comparison with its end markets could be the increasing complexity of semiconductors. The Federal Reserve Board measures units produced of semiconductors, electron tubes, capacitors, printed circuit boards, resistors and other electronic components. They don't account for the fact that a function in a computer that used to require 10 devices now may require only one.

The statistics muddle the components industry performance for other reasons as well. The government gathers data from companies for which their primary product is components. A computer manufacturer that produces printed circuit boards as one step in the entire production of its final product, the computer, is not counted in the government's final tally of U.S. components. (Yes, that's the problem all analysts have measuring the captive markets.)

Despite this statistical quicksand, one fact stands firm. Imports of components continue to grow. According to the U.S. Census Bureau, imports accounted for 36% of U.S. apparent consumption of integrated circuits in 1987, up from 24% in 1984. Other component markets' import shares have risen as dramatically: capacitors up 35%, from 22%; printed circuit boards up 14%, from 8%; resistors up 38%, from 24% and connectors up 10%, from 5%. Where have all the components gone? Overseas.

ELIZABETH BAATZ

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SIX DOLLARS

A CAHNERS PUBLICATION

Electronic Business®

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

APRIL 3, 1989

From left to right:
Gateway Design CEO Prabhu Goel,
Mips CEO Robert Miller, Weitek
president Arthur Collmeyer

BIG LESSONS

FROM SMALL COMPANIES

Solid strategies from the little guys

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No inflation fears for high tech PAGE 17

Hard sell: Chip makers vs. Detroit PAGE 100

Electronic Business
FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE
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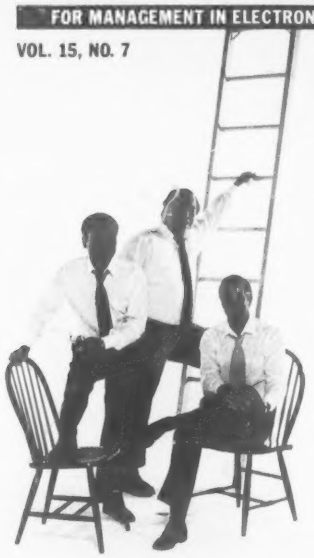

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The stereotype of the small electronics company — of the maverick engineer laboring far into the night in a California garage — is no longer accurate. Today's U.S. electronics entrepreneurs show remarkable clear-headedness when it comes to business. They have a keen sense of timing, a feisty opportunism that has already put them on fast growth paths, and a nimbleness that they insist on maintaining. Electronic Business details how the strategic thrust of three of these small firms may have applicability far beyond their small size.

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Artistic excesses

Bill Cooke, senior art director

We're proud of our artwork and graphics around here. We're especially proud of some of our covers, and this one is arguably our most striking ever.

So it's not inappropriate to hand the credit to our art director, Bill Cooke — that's him in the picture. We usually use this column to host our writers, but Bill deserves this space because he has gone to great lengths to back our small companies story with visuals that ram home the point. Given the editorial theme — that small electronics companies have solid strategies for success that many big corporations would do well to note — Bill opted for the stark drama of smaller figures against a bright white background, with primary colors as accents, and props, such as the ladder, as cues that hint at the small companies' direction.

Chris Springmann, photographer

But Bill's creativity would have been wasted if it hadn't been translated onto film by photographer Chris Springmann — also pictured. Springmann is one of the best practitioners of the art that we know; we like him because he loosens up stiff electronics execs, stage managing the proceedings like a movie director, yet ever mindful that senior managers don't have time to be utterly frivolous.

This shoot was no exception. At Bill's direction, Springmann rented a much-bigger-than-usual studio, assembled the props and had them spray painted in primary colors. But when he couldn't find neckties to match those hues exactly, he spray-painted the ties, too. He had the three execs tie their ties, then he snipped them free at the back, painted them, let them dry, and had the subjects put them on again — this time pinned in place.

Now that's what I call giving 100%. We think that the result is extraordinary. We hope you do too.

JOHN KERR, editor

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BPA ABP

Power supply makers put the push on quality

Vendors are being driven by customers to increase quality — and some are doing it. Field MTBF could go as high as 1 million hours

BY JOHN McCREADIE

While the power supply industry traditionally has been perceived by many as unglamorous, and even viewed by some as a "weak link" in the electronics chain, power companies are surging forward to dispel those negative perceptions once and for all.

The weak link perception stems mostly from high failure rates commonly accredited to power sources. As a result, merchant power suppliers are trying to change customer views by increasing product reliability, mostly by seeking better components and investing more in product testing. Part of shaking those negative perceptions, however, may depend on something unfamiliar to many power supply companies — aggressive marketing. Many manufacturers, due mostly to an industry shift from engineering to customer-driven designs, are putting more emphasis on product marketing.

And despite an already power saturated U.S. market, a few foreign companies continue to make headway here. This is keeping U.S. manufacturers, still eyeing low-cost offshore manufacturing sites, on their toes, causing some well-established industry names to even rethink their strategies.

Industry consolidation

As the industry continues to mature, consolidation, likewise, endures, occurring in some high places during 1988. Most significant is Unitech Plc's acquisition of Veeco Instruments Inc., the parent of one of the most recognized names in world power supplies: Lambda Electronics. But is continuing industry consolidation a preface to a shakeout?

The overall outlook for the industry is modest growth into 1990. Currently, worldwide consumption of power supplies is forecast to grow 8% to $13.5 billion this year (of which about $5.5 billion is merchant business), up from $12.5 billion in 1988, says Mohan Mankikar, president of Micro-Tech Consultants, a San Francisco-based market research firm specializing in the power supply industry. But Mankikar warns the worldwide growth rate may appear higher because of the dollar's weak exchange rate during 1988.

Domestic consumption is growing at a similar rate, from $5.7 billion in 1988 to $6.1 billion in 1989. The merchant market, which increased 3% over 1987, has gained most of its growth from offshore manufacturing, says Mankikar. However, echoing concerns of economists who predict a downturn in the computer industry early in the next decade, Mankikar says lean times may be on the horizon for power suppliers that, as a whole, have become very dependent on that industry.

Problems surrounding product reli-

Martin Cooke

Lambda's Irving Gutman: The "merger" with British Unitech will give Lambda a strong position for taking advantage of the 1992 unification of Europe

ability are not unfamiliar to power suppliers, a major reason some consider the industry a weak link. The problem was compounded in the early 1980s as the industry shifted from linear to switching power sources, causing failure rates to increase — a "universal toe-stubbing," as one observer described it.

But power suppliers claim that both calculated and field mean-time-between-failure (MTBF) rates have increased substantially. Average field or observed MTBF, total operational hours divided by total number of failures, has increased from about 100,000 hours four years ago to a range of 300,000 to 600,000 hours, estimates Bruce Hamilton, vice president for marketing and engineering for ACDC Electronics of Oceanside, Calif. He adds that 1 million hours field MTBF will be achieved in the very near future.

Power suppliers are certainly being driven to increase reliability, not only because their customers are demanding it, but also because of the cost reduction in having lower return rates. Thus, price considerations are taking a backseat as manufacturers scramble to ensure greater product reliability.

To accomplish this, power supply makers report aggressive programs designed to qualify reliable component vendors right from the get-go. Qualifying vendors, a method imported from Japan, is helpful because "it puts the burden of responsibility for shipped parts on the supplier rather than on incoming inspection," reports industry researcher Mankikar.

Closing the weak link

Such vendor qualifying has led power suppliers to narrow their component vendor bases and create stronger long-term relationships. Likewise, power manufacturers report they are also working more closely with their customers early on in the design cycle, a process many say will help alleviate the "weak link" perception. "We feel we can become part of our customer's design team," says Norm Berkowitz, president of sales for Power Conversion America (PCA), a division of Computer Products Inc. (CPI).

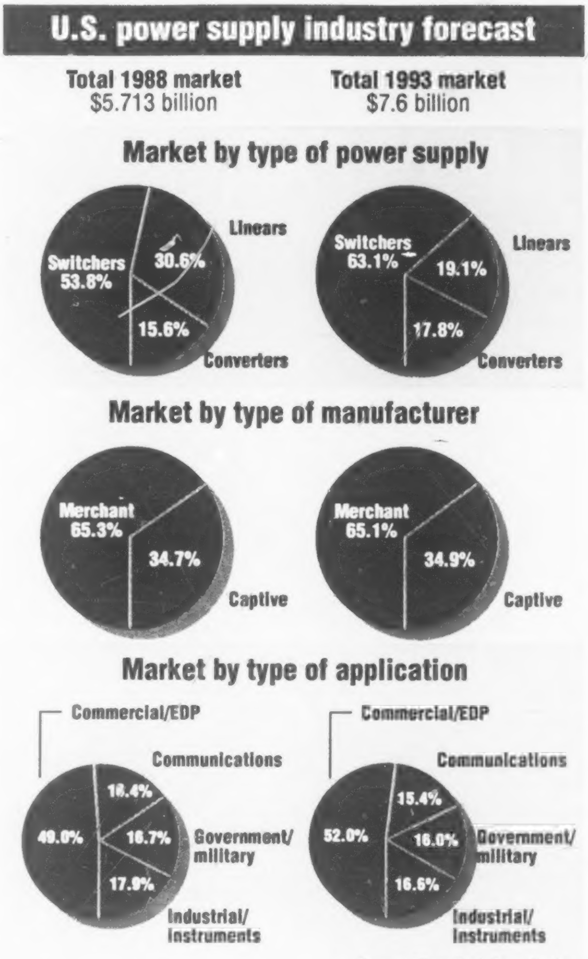
Laptop maker Grid Systems Corp. of Fremont, Calif., buys AC/DC high frequency switcher power supplies from about six manufacturers, but declined to give names. Grid's senior vice president for operations Chuck Waggoner reports working closely with his firm's power suppliers in a complex screening process to ensure both the company and its products are reliable. "We had to make some changes in the past because vendors were not reliable," he says, a decision not made lightly in view of the extreme time and cost Grid invests in finding and working with new vendors.

Extensive testing and process screening are increasingly important to power supply builders, but costs are high. Screening Systems Inc. of Irvine, Calif., a manufacturer of vibration screening units used on production lines to find product flaws early on, reports an increasing number of its customers are from the power supply industry. The equipment cost: $70,000 to $200,000.

Still others are employing more traditional methods, such as employee incentive programs. Unipower Corp. of Pompano Beach, Fla., a CPI spin-off that makes encased medium- and high-wattage power converters, holds weekly employee quality meetings and is organizing an employee incentive program aimed at customer service.

In an industry where long warranties are sometimes offered merely to enhance the image of quality, manufacturers are now going to great lengths to prove product integrity. Qualidyne Systems Inc., one of Unitech's holdings, uses its track record to convince future buyers of product reliability, insisting new customers call past customers in addition to reviewing in-house test and burn-in results.

One impetus for improving quality may be increasing competition from foreign manufacturers. Hong Kong-based Astec U.S.A (HK) Ltd. has increased its revenue in the United States 35%, from $96 million in 1987 to $130 million last year. Japan-based Shindengen America Inc., which for the past two years has inched its way into the U.S. market, will be focusing its efforts on market niches in the industrial and instrumentation markets. "We're also looking at the workstation market," says Peter Gajewski, vice president for


U.S. power supply industry forecast

Total 1988 market $5.713 billion — Total 1993 market $7.6 billion

Market by type of power supply

Market by type of manufacturer

Market by type of application

Source: Micro-Tech Consultants

Top power supply manufacturers

Fiscal year 1988 sales ($ millions)	Total power supplies		AC/DC switching power supplies	
	Worldwide	U.S.	Worldwide	U.S.
Astec	$215	$130	$195	$105
Lambda Electronics*	205	97	164	78
Shindengen	186	2	142	2
Tamura	130	13	45	11
Computer Products	102	85	65	55
CEAG	80	25	68	23
Emerson	80	77	75	70
Zenith	70	56	70	56
ITT Power Systems	65	60	65	60
Unitech*	62	15	49	12

* Unitech's acquisition of Lambda took place after fiscal year 1988

Source: Micro-Tech Consultants

sales and marketing for Shindengen.

Meanwhile, some U.S. companies are changing their strategies in an effort to be more competitive. The most dramatic change is a restructuring undertaken by PCA. In the early 1980s, CPI had tremendous momentum, acquiring strong power suppliers like Boschert Inc., but stumbled severely in 1986 and 1987, reporting net income losses of $8.8 million and $11.3 million, respectively.

Moving its operation base in late-1988 from Pompano Beach to a more strategic site in Fremont, Calif., PCA eliminated many products and consolidated divisions to streamline its operations, reduce costs and bring the company back to profitability. This cost an estimated $6 million.

Many custom power suppliers are moving into standard switchers and converters. Astec is making such a shift to broaden its product offering in the PC market, although its main business will remain in the custom arena. Likewise, ITT Power Systems views offering a few standard products as a way to enhance its custom business, a kind of modified standard approach.

In an attempt to stay competitive, U.S. manufacturers are forever eyeballing additional offshore manufacturing locales to keep their products price competitive. For manufacturers such as Zenith Electronics Corp. and ACDC, Mexico has been a hotbed for low-cost manufacturing that offers relatively easy transportation channels into the United States. And CPI, which manufactures in Hong Kong, is seriously looking to Mexico and the People's Republic of China as possible manufacturing sites, while others tout Thailand as the newest "in" spot to build.

Global giant

Consolidation has been occurring in this industry for the past several years, not surprising considering there are, by official accounts, more than 400 power supply companies. Unofficial estimates claim upward of 1,000 power-related companies actively doing business in a market in which no one company has more than a 7% market share.

The acquisition of Melville, New York-based Lambda by Unitech of Reading, England, is one of the most significant unions in the history of the industry, creating a worldwide giant in power supplies with combined revenue totaling $270 million for 1988. Still, the teaming is only a small ripple in the worldwide market, grasping at a market share of less than 5%. (Note: Revenue figures for Unitech and Lambda are charted separately because the acquisition occurred after fiscal year 1988.)

Price considerations are taking a backseat as manufacturers scramble to ensure greater reliability

Unitech, a name slowly gaining more recognition in the United States, is a conglomerate of 32 companies with annual revenue of more than $400 million. Unitech holdings Coutant Electronics Ltd. and Weir Inc. are well-established power suppliers in Europe with combined revenue of $44 million. In the United States, Qualidyne is a $16 million company that mostly sells standard products to OEMs.

Irving Gutman, Lambda's group vice president for marketing and sales, calls the Unitech acquisition a "merger," and says all of the Unitech power supply units will combine research efforts and market each other's products. The Unitech/Lambda teaming captures all of the major markets and especially gives Lambda a strong position for taking advantage of the 1992 unification of Europe. So, what other markets are left to be conquered? Says Gutman: "I'm trying to make my connections in the Soviet Union now that they seem to be opening up."

Even with Emerson Electric Co.'s latest acquisition of Powertec Inc. of Chatsworth, Calif., at the end of last year, most industry observers say a shakeout is unlikely. "I think the small guys are going to keep spawning," says Bob Wakefield, president of ITT Power Systems Corp. "The cost of entry into this business is so small and a key characteristic among buyers is they will buy from the small guy."

Still, others see investment costs for start-ups increasing because of more complex designs and testing. Thus, customer-driven demand for greater quality may be the ax that will sever easy market entry. "The investment level required to be in business long term is high," says ACDC Electronics' Hamilton. "Reliability — do you think that comes free?"

Although many power suppliers are making an honest effort to improve reliability, some fly-by-night operations are bound to exist in a market as big as this. Because of extreme fragmentation and few power industry standards, those reliant on power suppliers will have to use caution when chosing a vendor, weighing both quality and price, and performing testing of their own. But a major industry shakeout, say some observers, may be the only way of eliminating less quality conscious manufacturers and moving closer to creating some viable industry standards. ☐

Silicon Valley and Detroit shuck off past animosities

Semiconductor firms fashion a new business attitude toward automakers in order to cash in on a growing market desperate for the technology

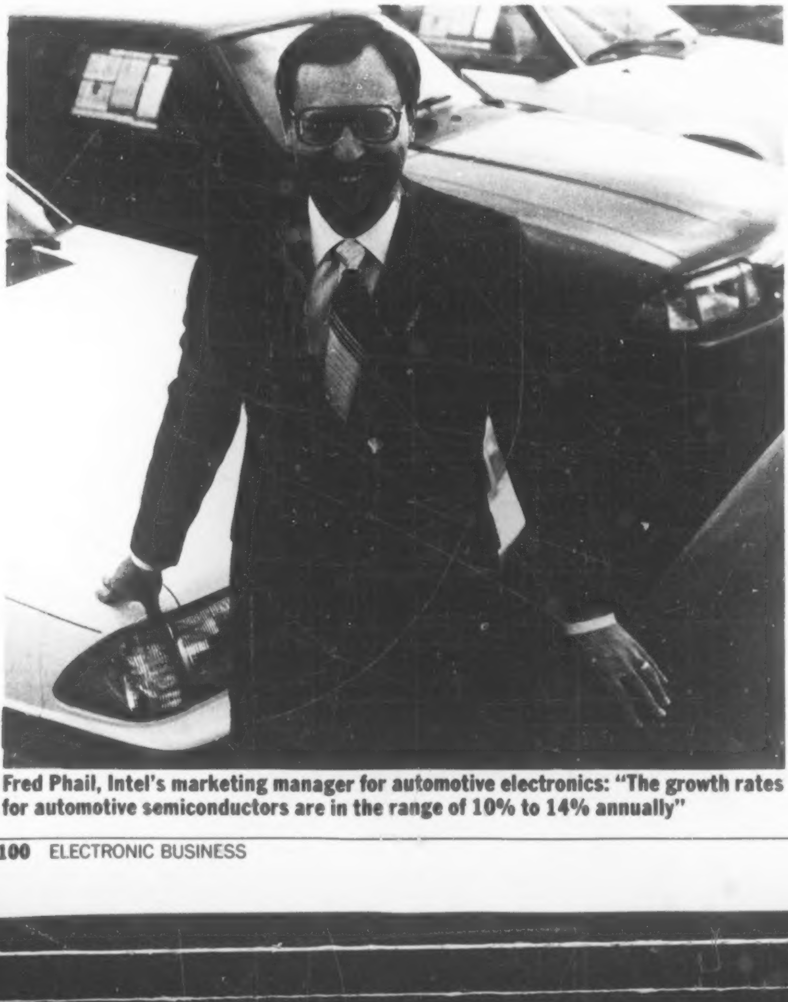
BY JEFFREY ZYGMONT

Semiconductor companies do almost anything to please their automotive customers. They kick in extra money for product development; they speed up chip production; they even make a point of delivering shipments on time. It's a new attitude for chip makers. In their first 20-odd years, these youthful companies have enjoyed a charmed, collegiate sort of business style. After all, they create the technology that leads to so many nifty new things, from faster computers to tinier pocket calculators.

But doing business with auto companies is like growing up, graduating, and going out to face cigar-chomping deal makers who don't care if you're missing spring break down at Fort Lauderdale. Carmakers aren't won by technology advances the way other big semiconductor customers are. They have their own rules. They want electronics that are custom designed for cars, that work both in subarctic and super-tropical temperatures, that stand up to a decade of exposure to grease, water, soot and vibrations. And they want some homage and servitude, a little bit of healthy groveling. "They expect us to pay them for the privilege of selling parts to them," summed up one electronics supplier.

It's a whole lot easier selling to computer companies and their ilk, which understand and even appreciate the ways of the semiconductor industry. Yet Silicon Valley is sticking by Detroit, taking its tactics like a spoonful of medicine. That means struggling with a rust-belt procurement process that is itself in a violent upheaval as auto companies shuck off their old, adversarial approach to suppliers and shop for "strategic partners" that will help them design and build better cars. The semiconductor companies winning the contracts are doing it by tailoring special operations around the needs of auto companies, working toward closer cooperation, even learning about the likes and dislikes of people who buy cars. In a spirit of conciliation, some electronics executives even concede that their own haughty, technological smugness fanned the animosity between their companies and the Big Three automakers, General Motors Corp., Ford Motor Co. and Chrysler Corp.

They want not just a truce, but an alliance. For electronics companies, automobiles represent a growing market that's stable and predictable, without the crippling swings in demand that plague many newer, hotshot products. "Maybe you can't grow 50% in one year like you can in the computer industry, but you won't drop 30% the next year if sales are off," explains Mike Eisele, automotive programs manager for Intel Corp.'s automotive operation in Chandler, Ariz. Not only are the peaks and troughs in auto demand much less severe, they also run oppo-



Fred Phail, Intel's marketing manager for automotive electronics: "The growth rates for automotive semiconductors are in the range of 10% to 14% annually"

Tom Gerczynski

John Stark, manager for purchasing for Delco Electronics: The 12- to 20-week chip fabrication time remains a big headache

Tod Martens

site those in other electronics markets. Thus, chip makers expect automotive electronics to dampen their more volatile markets.

But more than that, automobiles are simply a large market that's getting bigger all the time. "The growth rates for automotive semiconductors are in the range of 10% to 14% annually," says Fred Phail, Intel's strategic marketing manager for automotive electronics. His company expects the worldwide automotive semiconductor market, excluding discrete devices, to reach $4.7 billion by 1995. In North America alone, Intel expects automotive semiconductor consumption to reach $1.4 billion in 1991. In 1987 it totaled about $900 million.

Growth in chassis systems

Since computerized engine controllers were first used in the United States in 1976, automotive electronics have spread rapidly. Today, virtually every U.S. car has at least an engine computer. Many have additional microprocessors embedded in radios and climate control systems; in trip computers that help drivers figure distances and fuel consumption; in controllers for transmission, brakes, instruments, steering, rearview mirror; even for six-way power seats. Much of the growth will be in chassis systems — features that affect the way a car rolls, stops, takes bumps and handles turns. Under development are collision avoidance systems, traction controllers that prevent wheels from slipping during quick getaways, even active suspensions, which replace springs with hydraulic rams that position wheels in response to a computer that senses road irregularity. All in all, electronics promises to redefine auto locomotion, and Silicon Valley is outright dizzy at the prospects. Semiconductor and electronics companies now rank among the most outspoken automotive visionaries.

However, Detroit's approach has been tempered by caution. First, there is the problem of history. Compared with electronics, automaking is an ancient art. Car designers and engineers work wonders with metal; manipulating electrons on a slice of silicon is still black magic to many of them. Further, carmakers have a neurotic concern for safety and reliability, the two qualities motorists demand above all others. Therefore, they submit new semiconductor products to painfully slow testing and evaluation. A supplier can expect a three- to five-year wait before finally getting the go-ahead to start mass producing a new chip, a long wait before finally cashing in its investment — the supplier typically has to pump in additional money to keep the program alive through the evaluation.

Competitive weapon

Caution notwithstanding, automobile companies desperately need electronic technology. At the start of the decade, precise, computerized engine control was the only way they could meet federal regulations. Today, advanced electronic features are a powerful competitive weapon in a market battle that's getting fiercer all the time. Automakers want electronics to make their cars work better than the competition's.

"In the past four years, automotive companies have made tremendous advances in understanding electronics," says Ron Souter, U.S. marketing manager of Intel's automotive operation. Still, their expertise is strongest when it comes to moving metal — involving technologies that electronics companies know nothing about. Thus, the two sides are joining in partnerships that allow them to tap the strengths of the other.

For car companies, partnerships aren't unique to electronics suppliers. Since the early 1980s, U.S. automakers have been diligently revamping their vast supplier networks, getting rid of many and strengthening bonds with those they keep. In many cases, car companies are asking suppliers to participate in mutual engineering projects, in which the supplier gets an early say in how a component or system should be designed. That's particularly important in electronics. The technology is fast-changing and very complex, especially when applied to automobiles. Therefore, it requires a high level of intellectual exchange, explains Robert Parker, a 16-year Ford veteran who now heads the consulting agency Parker Management Associates in Wheaton, Ill.

Beyond chip makers, the Big Three are relying more and more on the electronics expertise of companies like TRW Inc., United Technologies Corp. and Robert Bosch — old-school suppliers that are experts in wedding electronic control to moving parts. "The automobile will always be a mechanical device. It will never have electronic tires," illustrates D. Richard Harmon, TRW vice president and general manager of the transportation electronics division in Farmington Hills, Mich. TRW incorporates electronics into many of the $3 billion worth of parts it sells annually to car companies around the world, including occupant restraint systems, steering assemblies and even electric switches.

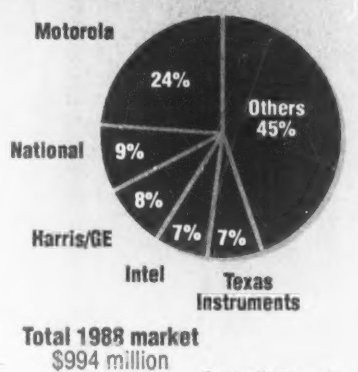
Fewer suppliers

Delco Electronics, the subsidiary of General Motors, has cut its number of suppliers of electronic material — everything from integrated circuits to plastic housings — to fewer than 500. It will reduce the number further, to around 400, says John Stark, manager for purchasing. "It's a matter of refinement now," he explains. That's good news for the suppliers who make it. For example, one company now supplies all capacitors for the 4 million cars GM manufactures each year; in the early 1980s, seven did. "Think of the volume — it's unbelievable," marvels Mike Doyle, director of world automotive marketing operations for Motorola Inc.'s Semiconductor Products Sector in Phoenix.

Even better, suppliers on the inside get a lock on future business. For one thing, the automaker becomes accustomed to working with them. Also, once its semiconductors are designed into cars, they can't always be easily replaced by another company; the competitor's underlying chip architecture may differ. It's not like buying a fender, in which any metal bender's product can match another's. "The companies that have had consistent relationships have a very good advantage," observes Intel's Eisele. "If you're not in, it's very hard to break through."

But establishing and maintaining a consistent partnership with a U.S. automaker takes a lot more than a handshake. Auto companies expect their partners to stay on top of technological advances, to participate — even help fund — joint development projects, to make ongoing efforts to cut costs and improve efficiency, to set up elaborate just-in-time delivery schemes, and generally to demonstrate unwavering support. "A contract doesn't make a partnership at all," explains Dale Spoon, automotive operations manager for Texas Instruments Inc. "Partnership is a philosophy and a methodology that we're operating under. It requires patience and a fair amount of up-front investment."

North American automotive semiconductor market



Total 1988 market
$994 million

Source: Dataquest Inc.

At times that's not enough. "The car people resent the fact that there is this enormous invasion of electronics into their products," says Parker, whose consulting firm specializes in managing relationships between supplier and customer. In February, his book on the subject, *Beyond Negotiation*, coauthored by John Carslyle, was published by John Wiley & Sons. "Automotive buyers attempt to treat the electronics industry as a rust-belt industry," he observes.

For electronics firms, automobiles represent a market that's stable and predictable

Car companies haven't yet demonstrated enough of the openness they say they're extending to suppliers, claims Parker. Rather than letting semiconductor companies participate in development, carmakers still sometimes hand over a finished design and expect chip fabricators to simply follow orders. "There's more stated partnership than real," Parker says.

That's partially due to the shadow of its past procurement practices, under which the Big Three ruled with an iron fist. Typically, contracts went to the lowest bidders and new bids were solicited each year. When you won a contract, "you didn't have long to sleep because next year you had to go through the same process and maybe lose the contract to a competitor," recalls Doyle, who worked for Ford before moving to Motorola.

"The internal incentive system isn't yet keyed to partnership," says Parker. For instance, the Big Three generally still reward their buyers for negotiating tough, low-price contracts, sometimes ignoring factors that make for strong partnerships.

Of course, automakers don't shoulder all the blame. "Semiconductor companies tend to send signals that they have a lack of patience with these metal benders. They have a technical arrogance," Parker says. But when performance measures are applied, chip makers fall short. Motorola ranks tops among Ford's chip suppliers, yet when compared with all Ford suppliers, the chip maker is near the bottom of the heap. "The electronics industry has a demonstrably bad reputation for failing to deliver what they've promised," charges Parker.

Delivery problems

Delco's Stark says the 12- to 20-week chip fabrication time remains a big headache, due especially to unpredictable schedule changes that result from swings in consumer demand. The problem, he says, is that semiconductor companies typically ship chips to the Orient for lower cost final assembly. "A lot of that time is just for transit," he complains. Some electronics companies are devising automated final assembly operations that may beat the cost of foreign labor.

Delivery problems creep up again and again in discussions both with carmakers and chip suppliers. Car companies want to feed their assembly lines with a steady flow of parts. But semiconductors aren't made in steady streams; they're processed in batches. Irritating delivery snaps result.

When you add it all up, says Parker, "the key problem is a lack of trust," because each side has been burned by the other.

But electronics companies are learning that they can be successful with the automakers by tailoring operations around their needs. Most have created special automotive operations within their companies, which operate differently than other company divisions. In 1982, for instance, Intel's automotive sales were handled by a focus group. By 1984, car business was elevated to an operation, which is an independent profit and loss center. Last year it was made a full-blown division within the company's embedded controller group. Because of the demands of the division's customers, "it's setting a model within Intel on how to effectively, continuously improve every aspect of our business," says Phail.

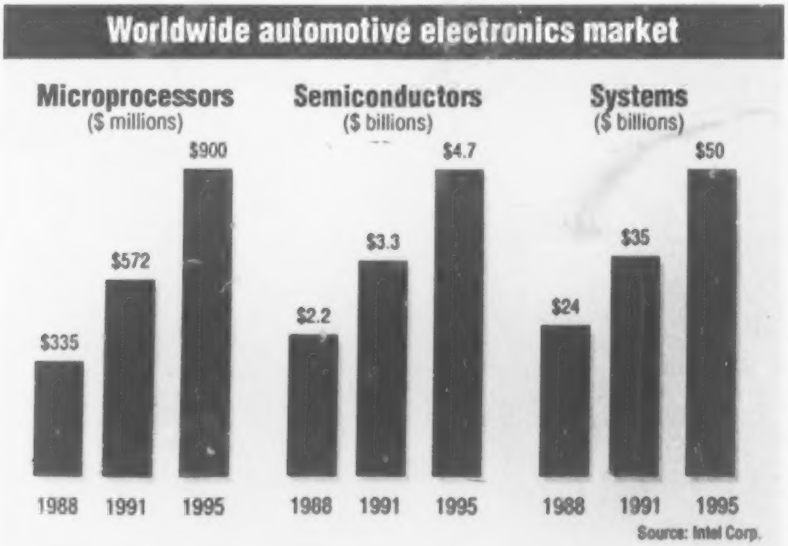
Motorola — the largest U.S. automotive semiconductor supplier with about a quarter of the North American market, maintains a flexible warehouse system that allows it to fill orders promptly and react to schedule changes. At National Semiconductor Corp. and Texas Instruments, special production planning departments anticipate the product needs of automobile customers and manage safety stocks to assure prompt delivery. "You must have the product they want when they need it, or they lose their sense of humor very quickly," quips Paul Standish, director of automotive marketing for National Semiconductor.

As part of its quality assurance and reliability program, National Semiconductor stations a person in customers' factories. "That's been instrumental in helping us achieve the business levels we now have," says Standish. Working with the plant's quality control staff, National Semiconductor's liaison heads off problems early. This often means correcting simple communication screw ups. Perhaps an incoming shipment is about to be rejected because it doesn't match the paperwork at the factory; The liaison may find that the parts incorporate an engineering change that reached National Semiconductor but not the factory. The problem is solved.

Texas Instruments spent about 18 months setting up a customized delivery system for the new Huntsville, Ala., plant of Chrysler's Accustar component division. The two companies' computer systems are linked, allowing Chrysler to check on the whereabouts of shipments. Texas Instruments gets a peak at Chrysler production plans, helping it anticipate its customers' needs. "We may have to react within hours" of production schedule changes, says Spoon.

All in all, electronics promises to redefine the concepts of auto locomotion

In short, suppliers must be willing to spend money to support their automobile customers. That's especially true in the development of new products. With a three- to five-year development span, "a lot of things can happen along the way," says Souter of Intel. "There is a higher element of risk, both in the qualification of the product and in the chances that the program may be canceled by the automotive company. We've had a number of instances where that's happened."



Worldwide automotive electronics market

Source: Intel Corp.

The trick is learning to be a market-driven company, something new for chip fabricators. Observes National Semiconductor's Standish: "Semiconductor technology has historically driven the computer marketplace. It does not drive the automotive marketplace." Thus, chip makers must learn what carmakers want, which equates to understanding what car buyers want.

Intel aims to do this by joining with Ford, its best customer, in a procedure called quality function deployment. Basically, each side deploys the functions it does best toward a mutual goal, in one case the development of a new erasable-programmable read-only memory chip. Both Ford and Intel assign people to the team, which operates in a brainstorming environment focused on evaluating what car customers want, then delivering it.

Cooperative efforts

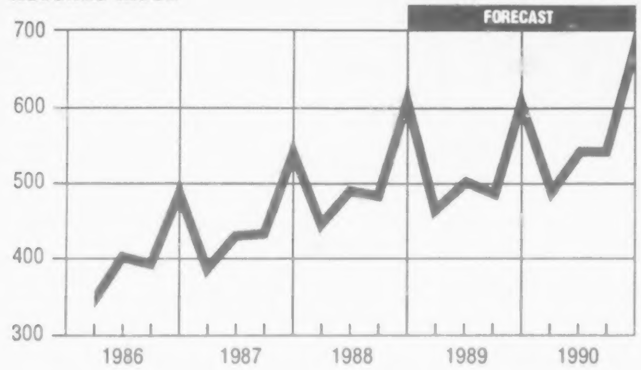
Although problems remain, both sides seem to be making sincere efforts at cooperation. "There's no way around it: You end up having to trust," observes Motorola's Doyle. "Suppliers have to understand the underpinning pressures affecting the auto companies so they can understand the actions of these big firms," he says.

Eventually, Detroit will become an easier place to do business. "Different companies and even different divisions within the same company are in different positions along the spectrum of change, but they are all on the same mission," according to Doyle.

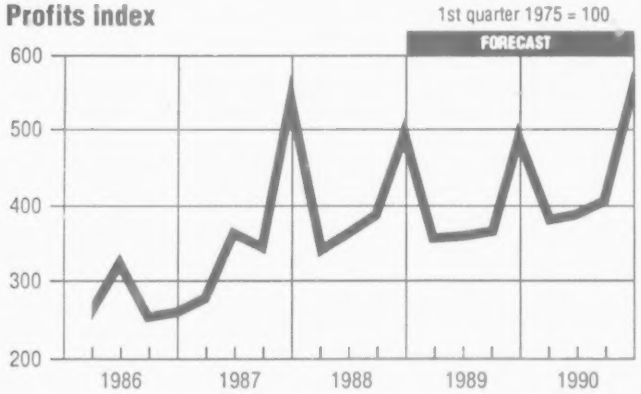
Still, the greater onus for change rests on the semiconductor makers. "The industry has accepted the fact that we have to do business the way the customer wants it," says National Semiconductor's Standish. Ask any college kid working the mall during summer vacation — the customer is always right. ☐

ELECTRONIC BUSINESS indexes

Revenue index

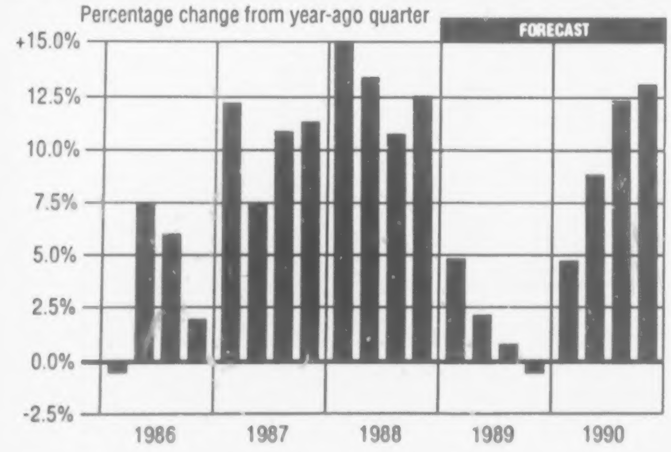


Profits index



Historical data: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Revenue growth for electronics companies



Historical data: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Electronics companies' profits rise 3.2% in 1988

Gone are the days of double-digit profits growth year after year after year for the electronics industry. In a disappointing — but expected — fourth quarter performance, profits at electronics companies fell 9.9% from year-ago levels. After a 41% surge in profits in 1987, profits for all of 1988 rose only 3.2%.

While profit growth slowed, growth in electronics companies' revenue held steady. Revenue grew 12.3% in the last quarter of 1988 compared with a year ago. In 1988, revenue expanded a reassuring 12.7% on the heels of 10.3% revenue gains the year before.

The biggest squeeze on profits probably was due to one factor: Rapidly rising prices for memory chips put upward pressure on input costs at computer manufacturers. Some speculation that computer makers were unable to get enough supplies to meet demand may mean production that should have taken place last year didn't happen. Will that circumstance help boost computer production in 1989? Perhaps.

While input costs dragged profits down, export opportunities blossomed last year. Companies which had significant foreign sales were aided by the continuing fall of the U.S. dollar. More competitive foreign prices made U.S. electronics exports profitable, in addition to assisting in market share gains against local producers.

Slower growth ahead

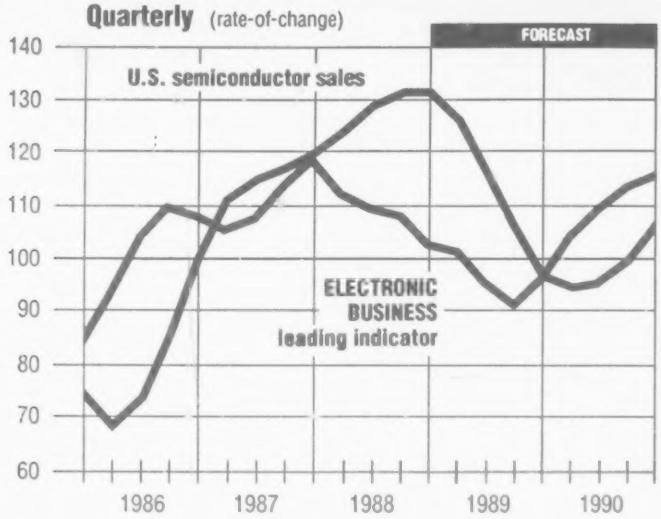
In 1989, the impact of input costs and export growth appears to be reversing. Profits are unlikely to plummet widely in 1989 or 1990, barring any serious industry recession. Business cycle dynamics dictate that profit growth cease in the latter half of 1989 or early 1990. Cahners Economics forecasts profits to drop 1%, with revenue growth continually growing, at a slowing rate this year.

The biggest drag on profit growth this year and next remains the persistent fear of recession. Stronger than expected growth so far in 1989 could be stealing from next year, putting the odds of a recession higher and higher, say many economists. Cahners Economics forecasts continue to assume average economic growth both this year and next.

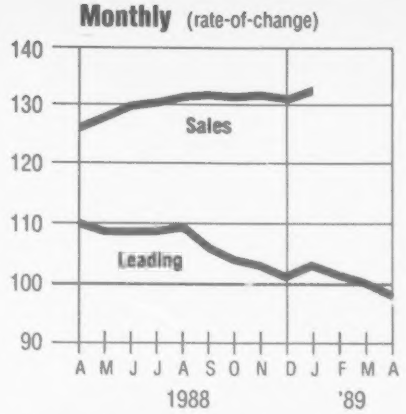
For electronics, the kind of overall operating environment should provide stability. And while stability won't provide any impetus for profits to surge to unimaginable heights or plummet to depressing depths, the industry should hold its own until the next wave of technology sends profits back up.

ELIZABETH BAATZ

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., [illegible]5 Washington St., Newton, Mass., 02158, or call (617) 558-4368



The ELECTRONIC BUSINESS leading indicator fell to 100.7 in December from a revised 102.8 the previous month. The rate of decline has been slow and the indicator may have flattened out in the early months of 1989. All the components of the indicator are dropping on a rate-of-change basis, but none as steeply as in 1985.

Source: Cahners Economics

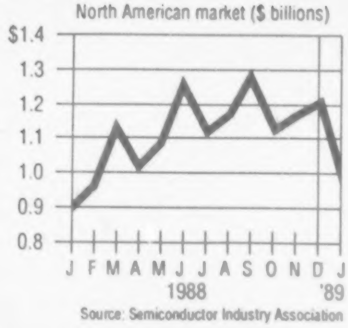
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1987 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Dec.)	100.7	102.8	117.7	111.1
U.S. semiconductor bookings ($ millions, 3-month average, Jan.)	$1,124	$1,066	$1,062	$951
Weekly hours of semiconductor production workers (monthly average, Dec.)	41.0	40.2	41.3	40.6
Electronic components leadtime index (1977 = 100, Feb.)	104.0	111.9	106.6	100.7
S&P's semiconductor stock price index (1970 =10, monthly average, Jan.)	49.0	45.8	53.2	65.5
Change in electronic components inventories ($ millions, SA, Dec.)	-$115	+$315	+$57	+$41
Contract and orders for plant and equipment ($ billions, SA, Dec.)	$43.2	$39.9	$38.0	$34.6

SA = seasonally adjusted, all other data is not seasonally adjusted

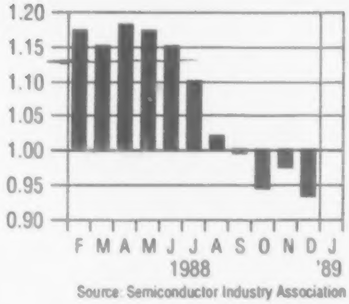
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



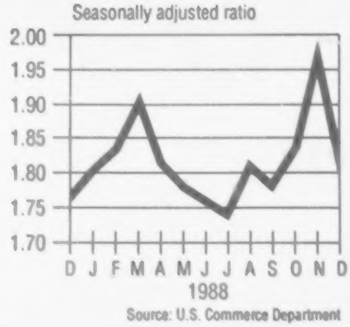
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department

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SIX DOLLARS

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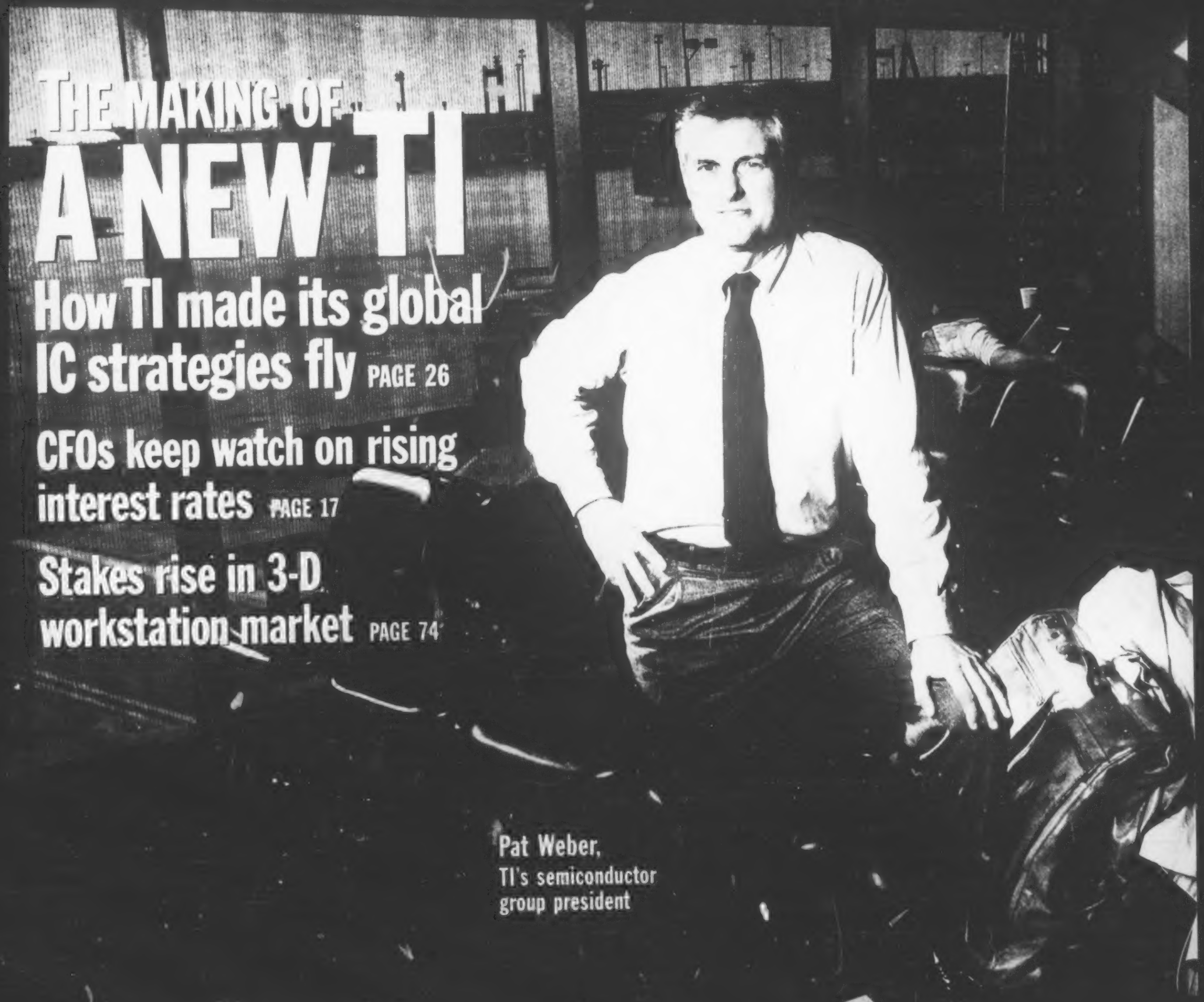

THE MAKING OF A NEW TI

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CFOs keep watch on rising interest rates PAGE 17

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Pat Weber,
TI's semiconductor
group president

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 17, NO. 8

APRIL 17, 1989

PAGE 26 TI semiconductor group president Pat Weber: "Today's technology businessman must be on a global time scale 24 hours a day"

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In 1985, when Texas Instruments Inc.'s president, Jerry Junkins, told the Wall Street community he intended to remain in the memory business, he was told he was "crazy, suicidal." But now a $3 billion global IC operation has Junkins and semiconductor group president Pat Weber laughing at Wall Street. Along with the burgeoning sales and profits has come a new TI — one that's less arrogant, streamlined and doesn't revolve totally around Dallas anymore. Clearly, TI's "not invented here" syndrome is out.

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High-tech executives are bracing their companies against rising money costs as the Federal Reserve Board struggles to hold down inflation by hiking up interest rates. Some view the credit-braking as overkill.

20 Swiss take initiative to fill engineering void

Swiss executives — mindful of Europe 1992 — are coming to grips with their industry-wide shortage of engineers. They are plowing ahead with plans to make engineering careers as tempting as Swiss chocolate.

STRATEGIES

26 The making of a new Texas Instruments

The DRAM business clearly helped TI — but for how much longer? Today, TI's strategy is to capitalize not only on DRAMs, but also on less noticeable areas such as digital signal processors and standard cells. And deal making, with the likes of Sun Microsystems Inc., hasn't hurt.

TI reshapes product lines along global responsibility

The key word for TI is global. So rather than having, say, separate memory managers in the United States, Japan and Europe, one worldwide manager is responsible in a profit and loss fashion.

Protecting the hard to protect: TI makes patents pay

Staying in memory has meant an aggressive "take no prisoners" attitude by TI to protect its patents. Over the past two years, the company has reaped about $315 million from infringers.

TI pioneers a market — DSP chips — and it pays

TI nurtured the digital signal processor market from virtually nothing to a 60% share today. Ironically, though, that may not be so appealing because as competitors catch up, TI can only lose market share.

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American Airlines and United Airlines are looking to dominate Japan's lucrative market for computer reservation systems, mainly used by travel agents. But hold on, say the Japanese.

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Australia's telecom industry is undergoing deregulation, well, sort of . . . sparking controversy and cries of unfair play. Eyes are cast at $6.1 billion government-blessed Telecom Australia, which is making commercial deals before handing over its regulatory duties.

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The West Germans are saying "No more," as low-level flight accidents killed more than 100 people there last year. The resulting political fallout means good news for the worldwide simulator industry, and West Germany is poised to become the proving ground.

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As technological advances pull down prices, vendors will have to shift marketing strategies and broaden distribution channels just to keep pace. Worldwide sales of high-performance graphics workstations are expected to more than triple to $1.9 billion by 1992.

84 A vision is fulfilled: VSATs flourish — finally

The hype and hope years have ended. VSATs — very small aperature terminals — are materializing and prices are falling, to the delight of wide area datacommunications users. Increasingly, VSATs are replacing existing phone lines.

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Office politics

A splendid story in the *Wall Street Journal* recently described the CEOs of the year 2000 — computer literate, multilingual, widely traveled folks who've hopped industries as comfortably as they've jumped company disciplines.

The new species is distinctly uneasy with Army-style hierarchies, preferring "offices of the CEO" where the boss is simply a first among equals and where consensus and teaming replace "head-honcho" diktats.

We're modeling ourselves that way too, and we feel that the resulting symbiosis will produce substantial benefits for our readers.

Instead of the traditional editorial structure, where the writers report to a managing editor, who, in turn, reports to the editor, we've set up a management triad — an "office of the editor," if you like — where the editor teams with an executive editor and a managing editor.

The executive editor — our new man is Jeff Bairstow, former *High Technology Business* senior staffer, accomplished editor and identifier of long-term industry trends — is the custodian of editorial quality. He is charged with assigning the right articles, ensuring that the incoming copy tells an informative story, and tells it accurately and attractively.

The managing editor — Roger Plant — takes up where Jeff leaves off: he's the expeditor who makes sure it comes in on time, to length and with all artwork complete; and who chases it through all succeeding production stages. Roger is a natural for the job — a seasoned production pro whose "big picture" view of the mechanics of putting a magazine to bed we couldn't do without.

From left: Roger Plant, managing editor and Jeff Bairstow, executive editor

Our intention is to bring you a magazine that offers the insight that the others don't. With Jeff and Roger as our top team, we feel we're positioned better than ever to make it happen.

JOHN KERR, editor

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BPA ABP

The making of a new TI

For Texas Instruments' $3 billion IC operations, global is in and the "not invented here" syndrome is out. DRAM business clearly helped — but for how much longer?

BY VALERIE RICE

It is 1985, and Texas Instruments Inc.'s president Jerry Junkins has just told the Wall Street community he intends to keep TI in the memory business.

"They told me I was crazy, suicidal," Junkins, now chairman, recalls. "It made TI look stupid."

Today he and semiconductor group president William "Pat" Weber are laughing at Wall Street. Fiscal 1988 semiconductor sales were $3.1 billion, up from $2.5 billion in 1987, with profits up by more than $100 million, due in no small part to Junkins' decision to remain in the DRAM market.

But although the dogmatic Weber still boasts that TI "is the best in the West," this is a different company from the one that made the fateful decision to stay in the memory business. From sales and marketing to products and alliances, Junkins and Weber have spent the past four years changing just about every facet of the company.

And they came to one painful conclusion: The world doesn't revolve around Dallas anymore.

Change for the better

Gone is the old arrogance, and in its place is a belt-tightening, streamlined mentality that can actually poke fun at the days when TI believed it walked on water.

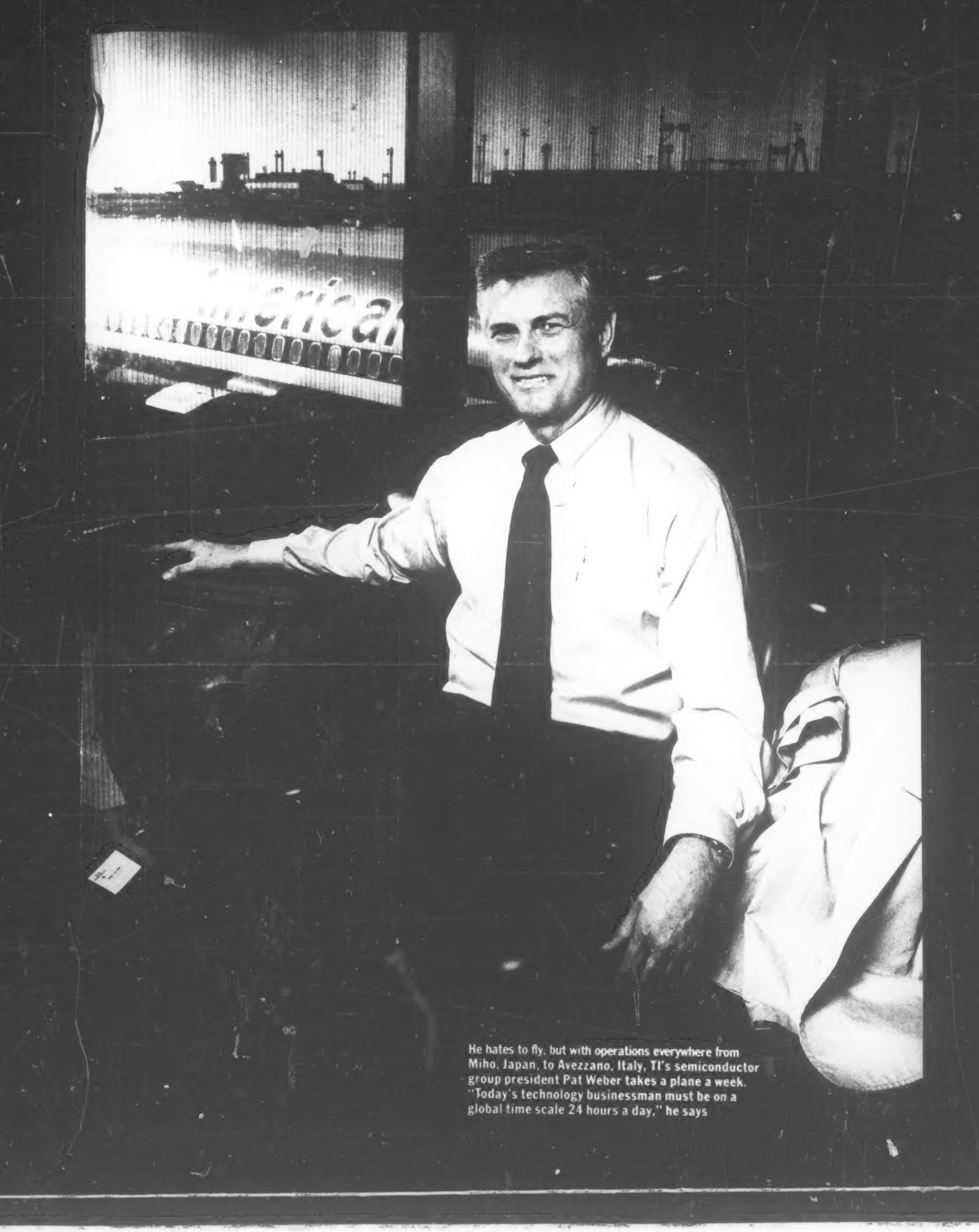
C. Thatcher

"We're not arrogant anymore," according to Weber a little wistfully. "You've got to be humble today."

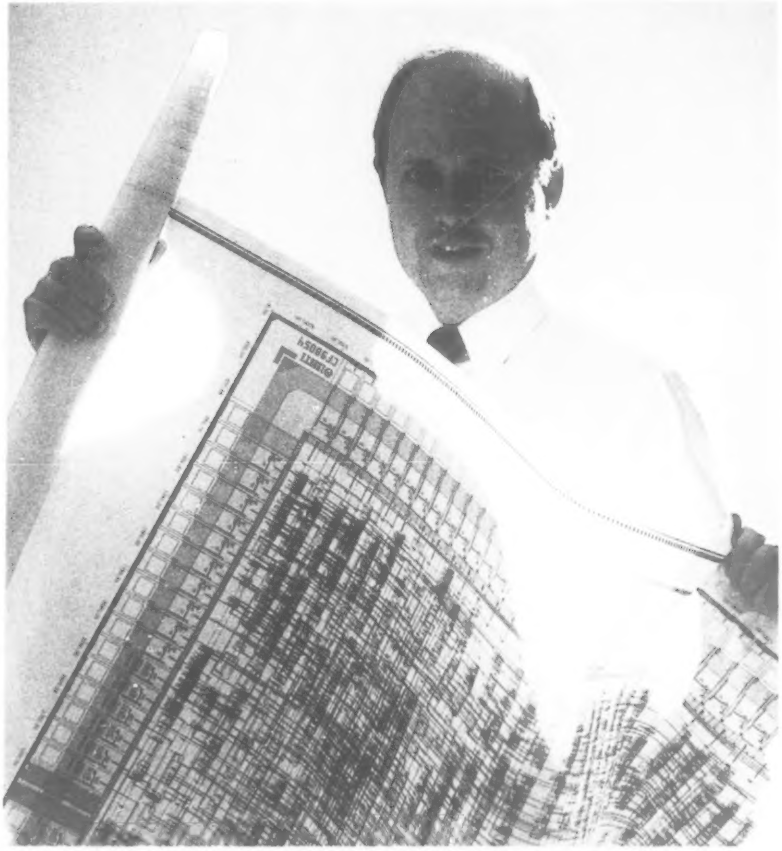
With that humility has come a completely new TI.

- Less is now more. The workforce has been cut by several thousand people since the hiring peak of 1984 to an estimated 27,900 employees worldwide. In fact, since 1987 the company has continued to cut back people, even though profits and revenue have increased dramatically.
- New noncommodity-oriented products are seen as the future of TI, from ASICs to application-specific processors.
- The company has gone worldwide. All semiconductor managers now operate on a worldwide product basis, rather than by region. Each group manager is responsible in a profit and loss fashion for his products worldwide.
- The "not invented here" syndrome, invented at TI, has died an inglorious death. Strategic alliances are the order of the day.
- And perhaps most importantly, TI employees for the first time are actually getting the counsel of their customers in designing products. According to executive vice president and group manager Walden "Wally" Rhines, "We spend twice as much time talking to our customers now as we used to."

It must be paying off. Graphics chip customer Larry Liang, president of Genoa Systems Inc. in Santa Clara, Calif., says that TI's customer



He hates to fly, but with operations everywhere from Miho, Japan, to Avezzano, Italy, TI's semiconductor group president Pat Weber takes a plane a week. "Today's technology businessman must be on a global time scale 24 hours a day," he says



Executive vice president Wally Rhines spearheaded TI's Sparc deal. With a host microprocessor on tap, he reckons, TI gets in early on a systems sale

Peter Poulides

service is really good now. Although Liang acknowledges that its software support is still a little weak, he says that overall, the company has improved in its dealings with customers. Spectrum Signal Processing Inc. marketing director Judy Bishop in Vancouver, B.C., adds, "TI is really easy to deal with now, once you get through the noise. They've become very responsive."

But one area that has not changed at TI is its belief in the critical importance of manufacturing for a worldwide semiconductor player. With 13 manufacturing operations in 26 countries worldwide, TI is in an enviable position.

For all the changing of its ways, TI remains ever conservative, heeding its traditional "go slow" Texan beliefs. "TI does not use a go-for-broke strategy," explains San Francisco-based Hambrecht & Quist Inc. analyst Millard Phelps. "For example, Intel Corp. likes to steer industry standards and industry software. If they miss, they are out of the market. TI is not inclined that way. They are not big risk takers."

But despite playing it safe, some obstacles remain. TI is still heavily dependent on commodity products that are facing the squeeze in 1989. Sales of DRAMs and transistor-transistor logic products represent more than half of the group's total sales in 1988, according to analysts' estimates. So, although TI has "changed for the better," says analyst Michael Gumport of New York City-based Drexel Burnham Lambert Inc., it will have to execute still more strategic changes in the future.

Strategies for change

Of all the changes Texas Instruments has made during its four-year metamorphosis, the most difficult ones have had to do with products. TI was known for inventing every product it sold (or practically so), and the realization that "they can't do it all anymore," says analyst Phelps, cost the company quite a bit.

"But the world is changing so we had to change," explains Weber of TI's technology relationships with third parties.

Today, TI's plan is to capitalize on its strengths, the most obvious of which is DRAMs. But there are other, less noticeable areas as well. From digital signal processors through an entire range of market-specific processors, TI has been carving out a niche for itself that does not require having a "hit" host processor (although TI has a strategy for this, too). Other areas, such as standard cells, find TI with a No. 2 worldwide market share — not too bad for a company historically weak on the customer support and service side.

By going "with what we do best," Weber says, the company is then free to do business with the top companies in areas where TI is not so strong.

TI's deal last year with Sun Microsystems Inc. of Mountain View, Calif., and Cypress Semiconductor Corp. of San Jose for design and manufacturing rights to the Sparc RISC microprocessor signifies TI's new beyond-Dallas attitude.

It's not too difficult to figure out why Sun wanted to do the deal. "TI is an international manufacturer in every sense of the word," says Sun's technology marketing director Bill Keating. "TI can play a much more substantial role in the Sparc industry than NEC or Siemens AG [the recently announced partners of arch-competitor Mips Computer Systems Inc.] can."

This strategy is equally self-serving for TI. Frustrated over the years by the absence of a host microprocessor, TI executives were looking for a way to get in on the design cycle earlier, says one former manager in the group. A host microprocessor, with its attendant pull-through sales, was just the ticket.

"It's very important for us to work with customers on systems design," says Rhines, an easygoing sort who spearheaded the Sparc relationship. "By having a host microprocessor, you can deal with a systems designer on a total problem basis." In other words, Rhines says, with a host microprocessor in the sales portfolio, a company can get in on the sale early — and stay there.

But that is not to say that TI will take over the world with Sparc. It is just one of five Sparc vendors, and it appears to have taken a backseat to earlier players such as Cypress, which seems determined to drive the direction of the technology. Rhines says that TI will "begin to see some [revenue] effect from Sparc in 1989," but how much is questionable.

"TI's not going to get rich selling RISC," says Morgan, Stanley & Co. analyst Andrew Kessler in New York City.

Groping for the future

That's O.K. Rhines has plans to parlay the rest of his VLSI products group's efforts into millions. To fill in the gap left by a nonexistent host processor, Rhines put together a strategy to offer market-specific processors for areas such as local area networks, graphics, communications and signal processing. Although analysts don't credit this portion of the business with more than $200 million in sales in 1988 (excluding DSPs), this is an area TI is investing in heavily for growth, Rhines stresses.

Like processors, ASICs are a big thrust, although a one-time partnership with Intel has not brought much to the party. Even Rhines admits that the relationship "has not given us what we thought it would." But newer relationships with both Altera Corp. and hot new start-up Actel Corp. promise to give TI a nice piece of change in the programmable logic market. This is also an area where TI, with its commodity orientation, can shine.

Not surprisingly, Junkins and Weber have both made it clear that the future of TI lies in two areas — memories, and the so-called VLSI products group, which contains Sparc, application-specific processors such as DSPs, and ASICs. Currently, however, the largest percentage of the company's sales comes from the volume products group, which includes standard logic TTL products, linear products and military parts.

According to Wall Street firm Paine Webber Inc., TI's sales of TTL products alone accounted for more than $1 billion in 1988, a third of the total worldwide market. And although that is a declining market, it is still going strong for TI. Memory was the next largest, at just over $700 million, with peripherals products and linear products at $500 million and $450 million, respectively, in 1988.

TI readily admits TTL sales are on the wane. Says semiconductor vice president and volume products general manager Delbert Whittaker, "This is a declining market. There

Let's make a deal, says TI

TI's strategic alliances

1982	IBM
1985	National Semiconductor
1986	Philips/Signetics, DEC
1987	Hyundai, Linear Technology, Ericsson, Intel, NMB
1988	Altera, Sun, Cypress, Actel, Hitachi

Source: Texas Instruments Inc.

TI reshapes product lines along global responsibility

Pat Weber hates to fly.

But as president of Texas Instruments Inc.'s far-flung semiconductor group, he's on a plane every week.

"It's hell," he says, "but today's technology businessman must be on a global time scale 24 hours a day."

The key word here is global. TI has been operating in Japan and Europe since the 1960s, making it one of the more global semiconductor companies. But the biggest change over the past two years has been the company's restructuring of product lines along global responsibility. Rather than having a Japanese memory manager, a U.S. memory manager and a European memory manager, one worldwide manager is responsible, in a profit and loss fashion, for all memories. Weber says this structure eliminates regional competition, eases resource allocation dilemmas and streamlines the structure. Now one manager can rule the world.

About 60% of the company's semiconductor sales come from abroad, with Japan representing the largest portion, followed by Europe and the rest of the world, according to analysts. TI is the largest U.S. supplier in Japan, and has been for some years.

But Europe is important, too. "It's scary how much pressure we are getting from Europe," says semiconductor vice president and group manager Delbert Whittaker. "You've got to be in Europe, you've got to be in Asia. In today's market, if you're not global, you're out."

About 60% of TI's semiconductor sales come from abroad

So TI has structured its operations to take advantage of its global presence, and it is trying hard to break down international barriers of communications.

One example: the sister fabs of Miho, Japan, and Dallas do more than look and operate alike. Each employee has a twin or counterpart in the other fab, and often employees switch jobs and locales for some period of time in order to keep the communications open. There is also a fair amount of good-natured competition between the two.

A satellite communications network also helps, as do regular teleconference meetings for sales and marketing staffs. A huge network of terminals, 50,000 plus, links managers worldwide, and information on any operation can be found with a few keystrokes.

For other semiconductor companies, TI should be a model for going global, says Dataquest Inc. analyst Michael Boss. "TI has really set the pace in establishing worldwide operations," he says.

"TI is viewed as a local supplier wherever it is," adds Hambrecht & Quist Inc. technology analyst Millard Phelps. "That's more and more important. They are present in every market, and they speak in German, or Japanese, or whatever." ☐

Delbert Whittaker, TI's semiconductor vice president and volume products general manager: Declining products can yield profits through careful management

Charles Thatcher

was a total available market of $3 billion in 1988, but that will drop somewhat in 1989. The days of the general purpose logic family are over."

TI's solution to that is twofold. First, the company is investing heavily in the future of logic, ASICs, with some analysts estimating TI to be putting 20% to 25% of its $600 million research and development budget into ASICs in 1989. Second, TI will not decrease its investment in TTL — on the contrary, there is still money to be made here, Whittaker says, pointing out that the market's $3 billion size makes it a huge opportunity.

The trick is staying ahead of the competition. Whittaker, a large, soft-spoken man with a long history at TI, believes that by careful management, declining products can yield profits. Over half of his general purpose logic business is outside of the United States, and the majority of it comes from older products from five to seven years ago. That means manufacturing is cheap and margins have been historically high.

And it's easy to target niches. Whittaker's strategy is to allow the customer to identify market niches, and then to move quickly to fill them. "It's all a matter of niche business now," according to Whittaker.

TI's other major niche business is in linear, where National Semiconductor Corp. offers some competition. TI, a world leader in linear, forged a relationship with aggressive start-up Linear Technology Corp. of Milpitas, Calif., for both design expertise and just plain manpower, according to Whittaker. With LTC in TI's court, Whittaker believes the company has some unbeatable advantages in linear, and it is one of the clear targets for high future growth. Investments are increasingly large here, and Whittaker says he has more business than he can handle reasonably. Leveraging TI's investment in a BiCMOS process has also helped in both linear and standard logic. That will be the future process technology for these products.

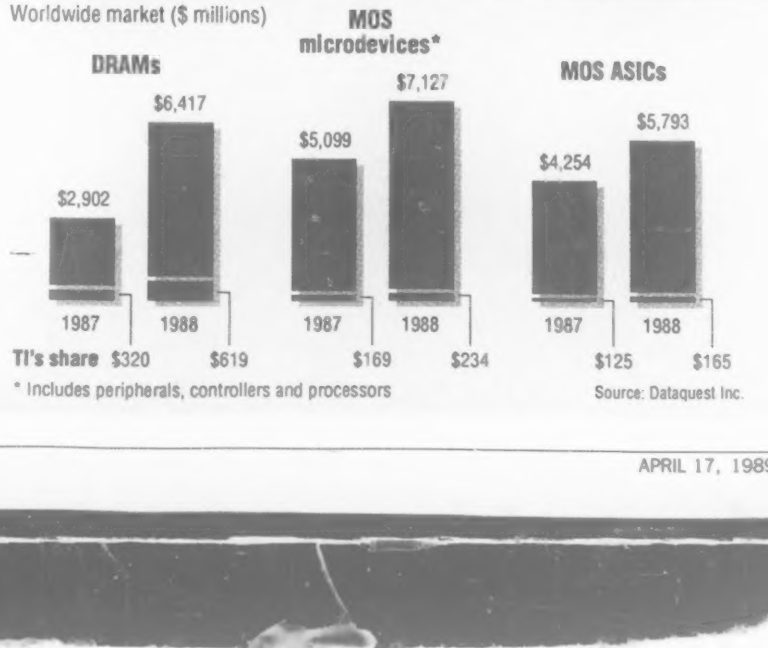
In fact, Whittaker says that in the past three years, there have been twice as many advanced linear processes developed as digital processes, which makes him believe the company has something to sell. "In linear, focus on the design know-how is in the past," he says. "Today, the emphasis is on process technology."

The DRAM dilemma

DRAMs, although not the largest portion of its business, are the most significant part of TI's manufacturing strategy. The sixth largest DRAM supplier in the world, TI has spent a substantial portion of its time and $500 million company-wide R&D budget over the past few years ramping up "sister" fab facilities in both Miho, Japan, and Dallas that are tailored to the new DRAM trench processes. With its recent announcement of the Avezzano, Italy, fab, TI will now tackle the 1-megabit and larger DRAM market with what it calls the "three brothers."

Combine those large investments with a steady revenue stream from memory royalty licenses, a research agreement with Hitachi Ltd. to explore the 16Mb DRAM manufacturing dilemma, and a leadership position in the embryonic 4Mb market, and it is clear that memory manufac-

TI puts more faith in DRAMs



* Includes peripherals, controllers and processors

Source: Dataquest Inc.

TI pioneers a market — and it pays

Texas Instruments Inc. should be envied its position in digital signal processors. Having grown the market from nothing, TI has more than a 60% share today — certainly enviable.

But the reality may not be quite so appealing. Ironically, TI is so dominant in DSP chips that "it can do nothing but lose market share," according to market researcher Forward Concepts Inc., Tempe, Ariz.

Forward Concepts estimates that in 1988, TI had $125 million in sales from general purpose DSPs, in a worldwide market estimated at around $215 million. That compares with TI's rival Motorola Inc., which "may do $10 million in 1988," according to Forward Concepts president Will Strauss. TI is also making money in DSPs now, while Motorola may have to wait another year or so, Strauss says.

Since Motorola has only been out with its part for less than two years, TI has a good running start on everyone else.

But there is some momentum going now in the market, and TI is going to have to work harder than ever to hold onto what it has built, analysts say. In addition to Motorola, competitors include AT&T and Analog Devices Inc.

But TI executives believe that old maxim, about imitation being the sincerest form of flattery, says group marketing manager Michael Haimes. "As the market has gotten very large, there have been a lot more competitors," Haimes notes, "so that just shows that TI was right."

As the first to really pioneer this market, TI is credited by customers and competitors for doing a number of things right. For example, several customers praise its aggressive university program, which put DSP development tools and software in the hands of 100 universities across the country, as instrumental in getting broad market acceptance. Haimes says TI also has over 80 active third parties to support customer requirements.

The challenge now, says Haimes, is to stay ahead of the competition and to continue to develop new products. With its four-year headstart, Haimes argues that TI will be able to stay on top since it has such a broad offering of products. "It is not just one homogeneous market anymore," he explains. "The market is splintering, and we can give customers different versions for new markets."

"TI has had more time, patience and muscle in the market," says Forward Concepts' Strauss. "They spent a lot of money conducting seminars and doing missionary work and now it has paid off." ☐

turing drives Texas Instruments.

That's fine with Weber.

"We are not talking just memory capacity here," Weber stresses. "We are talking advanced CMOS capacity, because I am going to be running logic processes in these memory fabs in the future."

The key is that every single product TI produces is leveraged from an advanced memory process. Older memory fabs are transitioned to logic and ASIC fabs, keeping all the processes on the cutting edge. From the company's linear ASIC product line to good old microprocessors, the memory process technology serves as a driver, and without it, Weber and Junkins believe TI could not assume a leadership position today.

Where does that leave the other major U.S. companies today that got out of the memory market when the getting was good? Out of luck, answers Weber, who says, "I would much rather be in the position we are in now than trying to get back into the memory business. This really separates the men from the boys."

With some analysts suggesting that between 25% and 30% of TI's revenue comes from memories and their royalties and a much higher percentage of the group's profit, TI is heavily dependent on the memory market for its continued growth. And perhaps, as prices decline, this is where an old-line commodity player like TI will shine. But some analysts aren't sure.

"They're not going to make a lot more money in DRAMs" argues San Francisco-based Robertson, Coleman & Stephens analyst Eric Jansen, who has rated TI's stock a "hold." "There will be a decline in prices down to less than $10 per 1Mb by the fourth quarter [compared with $15 to $18 in the first quarter] and that is going to affect them."

"DRAMs are going to be a problem in terms of managing profit and loss," states Morgan, Stanley's Kessler. "The [downward] price curves on DRAMs this year are going to be more than the average 30%."

An even gloomier view comes from a report from S.G. Warburg & Co. Inc. in San Francisco, where analyst Eli Sayegh argues that the drop in DRAM prices, the drop-off in royalty revenue and the easing of the shortage will combine to leave TI in a difficult profits position. Sayegh rates the stock a "sell."

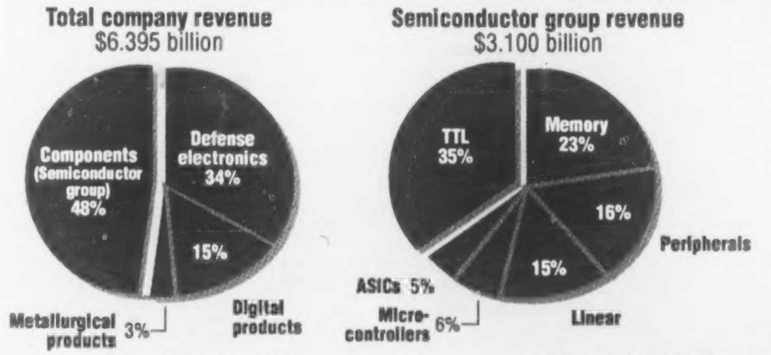
Weber, who dismisses analyst forecasts as too short term to be listened to, does acknowledge the downward pricing pressure on memories, but says Texas Instruments is well positioned.

"Pricing is going to return to the same horrible experience it was before," according to Weber. "But we are bringing our cost plans down the learning curve in a manner that is consistent with the pricing decreases."

TI anticipates that 1Mb DRAMs

At TI, chips are big — and TTL chips biggest

TI's sales for fiscal year ending December 31, 1988 ($ millions)



Source: Texas Instruments Inc.

Source: Paine Webber Inc.

will be at less than $10 by the fourth quarter, Weber says, but notes that, "We don't control the costs here. The Japanese do."

Meanwhile, demand may not be as weak as some are expecting. Texas Instrument's worldwide memory manager Robert England argues memory is a growing percentage of the total market every year (more than 30% in 1988), and that new applications, such as memory-hungry laser printers and faxes, will partially offset any downturn in PC demand.

When looking at growth in 1989, TI executives remain rather quiet. Highly conservative management ideals keep forecasting to a minimum, and the only thing clear is that 1989 won't be a banner year like 1988. In fact, most analysts are suggesting TI will grow 5% to 7% company-wide this year.

"If they make money at all this year they'll be doing very well," concludes Hambrecht & Quist's Phelps.

In any case, Junkins and Weber seem comfortable facing the worst case scenario, even to the extent of downplaying Texas Instrument's recent successes.

For 1989, Weber will not be relying on any miracle cure.

"It's going to take the industry a long time to recover [from the 1985 to 1986 period]," he offers. "We've got a long way to go before we can make up for the billions we lost" on the memory market. ☐

Protecting the hard to protect: TI makes its patents pay

Mel Sharp, TI's corporate counsel: "It's hard to get international companies to agree to value intellectual property if U.S. companies won't"

Charles Thatcher

Staying in the memory business had its price.

For Jerry Junkins, Texas Instruments Inc. chairman, the price was changing the rules.

"In the depths of the dumping," he says, "we took a look at our strategy and realized that the world had changed.

"It was tough, if not impossible, for us to receive the return we needed to have on our products in order to reinvest in the business, so we had to change the rules," he explains. "We had to have greater return from the marketplace on our royalties and we were prepared to enforce it with legal means."

And the rest was history. With a "take no prisoners" attitude, TI has aggressively pursued those it felt infringed, and has been perhaps the most successful company in wresting real dollars from patent infringers. Over the past two years, TI has reaped about $315 million from patent infringers. All this goes straight to the bottom line.

Senior vice president and assistant general counsel Mel Sharp oversees TI's thrust into the murky world of patent infringement. And Texas Instruments has certainly been on a roll here.

In the past three years, TI has doubled its number of patent filings, as well as greatly increasing its offshore filings. And it is filing on a broad number of things, Sharp says. "Ten percent to 15% of our filings are in the 'whacko' category," he explains. "We can never tell which are the jewels when we file. Looking back today, 25% of the time we're right."

Patent filing alone isn't enough. TI "needs a credible threat of an injunction to gain value in the market," Sharp stresses. And it has a credible threat. The company is currently involved in over 20 "discussions" of patent infringement, "as both plaintiff and defendant," he says. At the very least, TI has proven it is willing to go all the way to court or the International Trade Commission, if need be.

Although TI's most memorable — and profitable — successes have been offshore, Sharp believes that enforcement must begin at home. Witness the recent suit against memory upstart Micron Technology Inc. over DRAM patents. "It's hard to get international companies to agree to value intellectual property if U.S. companies won't," Sharp says.

To support all this activity, Sharp has increased his total staff to 60, and added a seven-lawyer contingent in Japan. "Trying to deal with the Japanese language as an American is difficult," he admits. Having a staff of Japanese attorneys "makes a lot of difference."

As to when the litigious activity will slow down, Sharp is not too optimistic. "I think it will take another five years of aggressive action on the part of TI and others before the message gets through." ☐

Reliability spells edge in competitive drive market

Disk drive suppliers are bucking reliability odds with enhanced design and quality control programs — often exceeding "plug-and-play" goals

BY DWIGHT B. DAVIS

The electronics industry as a whole spends a great deal of money and effort in the dual pursuit of making products both smaller and more powerful. Hard disk drive manufacturers are not immune to this preoccupation, as evidenced by the current spate of 3.5-inch-diameter disk products that store as much as 200 megabytes of data, and 5.25-inch drives that hold more than 1 gigabyte.

But packing more and more data onto a disk's surface increases the difficulty of ensuring that the electromechanical drive will operate reliably. Ironically, the importance of reliable operation increases with the disk's capacity, since the failure of a several hundred megabyte drive is much more critical than the crash of a personal computer's 20MB disk.

Fortunately, drive suppliers generally have been able to buck the reliability odds: the manufacturers have accomplished major mean-time-between-failure (MTBF) improvements in each successive generation of their products.

"In our first year or two, our products had mean time between failures of about 11,000 hours," says Steve Kitrosser, executive vice president for operations at Maxtor Corp., San Jose, which went public in 1985. "In successive years the MTBF climbed to 16,000, then to 20,000, and today our products offer MTBF ratings of 30,000 to 40,000 hours or better."

A number of factors have contributed to this industry-wide trend, including design improvements that reduce component counts and simplify manufacturing, as well as the development of more rigorous testing and quality-control programs. Driving this trend, in large part, have been OEM customers that have placed a premium on high product quality as well as on competitive price and performance ratings.

"OEMs are putting extreme pressure on us to deliver drives that work reliably right out of the box," says Ray Miller, vice president for quality and reliability at Quantum Corp. of Milpitas, Calif. Because Quantum has devoted so much attention to meeting this demand, he says, many of its customers have been able to initiate "ship-to-stock" programs, in which the OEMs dispense with their own testing of incoming products.

The operational success rate of the shipped drives — usually referred to as the "plug-and-play" rate — is measured by most vendors at the end of the OEMs' system integration processes, although some may quote simple out-of-box conformance to specifications. Miller says Quantum's drive specifications call for a post-integration plug-and-play rate of 99.5%, and claims that the company's drives often exceed that goal.

Bill Miller, president and CEO of Imprimis: "Our management has attached great significance to achieving quality"

Paul Shambroom

Carter O'Brien, director of marketing at market leader Seagate Technology, San Jose, which attained revenue of about $1.3 billion for the fiscal year that ended June 30, 1988, says the "comfort level" for most OEMs is a plug-and-play failure rate of no greater than 2%. "A failure rate of only 1% is great," he says, "whereas a rate in the 10% range would be disastrous." For his part, Dan Gust, a division manager at MiniScribe Corp., Longmont, Colo., says he would consider even a 2% to 3% failure rate unacceptable.

"Drive vendors should, in theory, be able to charge a premium price for products that allow OEMs to establish ship-to-stock programs," says Phil Devin, a senior industry analyst with San Jose-based Dataquest Inc. In reality, he says, many OEMs still rate product quality third in importance behind the cost per megabyte of a drive and its performance.

Nevertheless, Devin notes, the quality of competitive vendors' drives constitutes an important differentiating factor in the marketplace. Quantum's Miller agrees, claiming, "We've gained a number of large OEMs as customers because of our reputation for producing reliable products."

In the highly competitive hard disk drive marketplace, such an edge can prove critical. Much of the industry found itself engaged in price cutting last year, especially in the high-volume 5.25-inch drive sector.

In that market, suppliers, led by Seagate, ramped up their 1988 production of drives based on an expected boom in the growth of personal computer sales. The actual growth fell short of the projections and, at the same time, many PC manufacturers switched from the standard 5.25-inch drives to the newer 3.5-inch models.

The resulting overcapacity caused an industry-wide earnings slump, as drive vendors cut prices and retooled their manufacturing facilities to meet the demand for compact drives. Although worldwide revenue is forecast to rise 20.7% in 1989 over 1988, according to Jim Porter, president of Disk/Trend Inc., a Mountain View, Calif., market research firm, earnings at a number of the major suppliers are expected to suffer because of price cutting brought on by overcapacity and competition from market share.

At Maxtor, for example, third quarter 1989 revenue, ended Dec. 25, 1988, was $91.4 million, a 23% increase over the $74.1 million figure for the same period in the previous year. However, Maxtor's net income of $767,000 for the third quarter 1989 compares with $5.15 million the previous year.

"In a period of oversupply with all of the competitive drives in the same capacity range, product quality became the most important differentiator," says Maxtor's Kitrosser.

Reworking extremely costly

Aside from landing contracts, most drive vendors recognize that producing quality products helps them in other ways. "We want to achieve high first-time yields because reworking is extremely costly," explains Quantum's Miller.

Should flawed products slip through a vendor's hands and its OEM's testing procedures and into the field, the economic consequences can be immense. One such installed "time bomb" occurred with Control Data Corp.'s FSD II class of 9-inch drives in the mid-1980s. These drives suffered from premature wear of the disk's surface following repeated head contacts.

"Every vendor's FSD II class drives had significant problems," according to Bill Miller, president and CEO of Imprimis Technology Inc., Minnetonka, Minn., who explains that the 9-inch drives represented a jump in technology from their 14-inch predecessors of similar capacity. Imprimis was established as a wholly owned subsidiary by Control Data Corp. in September 1988, and supplies its parent company as well as the OEM marketplace.

Seagate's marketing director, Carter O'Brien: Other companies can take technology risks more easily

Liane Enkelis

Control Data did a commendable job of backing up its products, according to Mike Casey, director of storage industry research for market research firm InfoCorp, but at a tremendous cost. He quotes estimates that the drive snafu cost the company as much as $50 million to rectify. Imprimis' Miller will only say that "we spent millions and millions of dollars replacing drives and correcting the problem."

"Partially because of the FSD II experience," he continues, "we've established considerably more elaborate testing and quality control procedures."

Imprimis and its competitors have established a variety of programs and procedures to promote employee attention to quality. Maxtor, for example, provides all of its employees, from management on down, with a profit sharing plan.

The nature of the disk drive industry, however, is not such that a vendor's attention to quality control can end in house. Although some vendors such as Seagate and Imprimis are fairly vertically integrated, most U.S. suppliers rely heavily upon third-party sources for most components, performing only the initial design, the final assembly and the testing themselves.

Those that rely more heavily upon outside suppliers counter that they are able to exploit each supplier's expertise in component manufacture. This approach works well today, "because our supplier base is much more mature than it was several years ago, and their products are much more reliable," says Kitrosser at Maxtor.

Limiting third-party firms

Maxtor works closely with its suppliers from an early stage in each product's development, Kitrosser says, and has been limiting the number of these third-party firms in order to exercise better quality control. "Five years ago we were producing five to 10 drives a day and we had 13 different suppliers," he says. "Today we're producing thousands of drives daily, but we have only three major suppliers."

Another factor in the pursuit of reliability involves the diameter of the disk, or its form factor. Imprimis differs from other U.S. drive makers in that it produces hard disks ranging in size from 3.5 inches to 14 inches. "We offer the broadest product range of any U.S. drive company," president Miller says, while noting that different size drives introduce different reliability concerns.

"For example," Miller contends, "on a 14-inch drive, when the head hits the disk surface it has a greater physical impact than a smaller drive's head crash." However, this impact difference is due in part to the fact that, for a given areal data density, a large disk's head flies higher above the disk platter's surface than the head of its smaller counterpart, according to Miller.

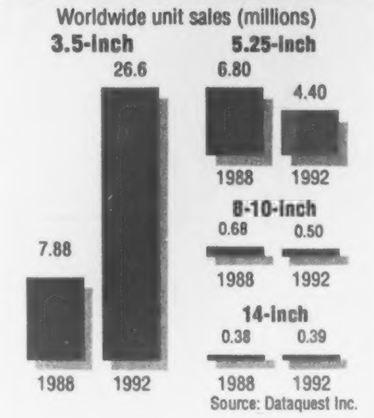
Smaller drives require higher packing densities of components than larger drives, he notes. Such distinctions require that vendors establish appropriate specifications and testing programs for each form factor.

Even more important from a reliability perspective than a drive's form factor, however, is the density of the data packed onto the disk's surface. As the density increases, the size of an individual bit cell decreases, as does the size of any contaminant that could cause a reading problem. The magnetic signal of each bit is reduced, and the read/write head consequently must fly closer — on the order of 10 to 17 microinches — to the rotating disk surface.

These tightening parameters inevitably up the potential of head crashes and other malfunctions. As a result, disk vendors find themselves in a situation of balancing the demand for higher capacity products with their ability to design and manufacture drives of adequate reliability.

"We often get 'dinged' for not being technology leaders," says Seagate's O'Brien, "but we can't risk it. With our high production volumes it would be catastrophic if a product had a short field life. Others can take the technology risks more easily."

Hard disk drive market



Source: Dataquest Inc.

Seagate's highest capacity 3.5-inch drive holds 83.9 formatted megabytes and its densest 5.25-inch product has a 168.5 formatted megabyte capacity. Vendors like Maxtor, Imprimis, Connor Peripherals Inc. and Areal Technology Inc. offer 200MB (unformatted) 3.5-inch drives; Imprimis and Micropolis have announced 5.25-inch products that store 1.2 gigabytes of unformatted data.

Maxtor's Kitrosser admits "There is no doubt that squeezing more and more data onto a drive makes the maintenance of quality more difficult," but he says Maxtor's understanding of how to attain such quality is well ahead of the level of products it is now producing.

"At the leading edge of technology, there will always be some increased level of risk," concurs Miller at Imprimis, "but we don't get out on the ragged edge. We go only as far as the technology will allow us to reliably go."

Most in the industry agree that factors other than pushing the technology limits are most likely to cause drive failures. "Cost cutting measures on the part of the manufacturers are more likely to cause quality problems than higher densities," says Dataquest's Devin.

Miller at Quantum says some disk drive manufacturers place pressure on their suppliers for rapid delivery of components at the expense of quality. "A supplier might normally require 12 weeks to deliver a shipment, and the disk drive house pushes for two-week delivery," he says. "It's when the manufacturer tries to exceed the capacity of its suppliers' operations that problems occur." ☐

Quantum banks on TQC — total quality control

Because the disk drive industry as a whole has an impressive quality record, even small differences in the competitors' product failure rates can make or break OEM deals. One company that has been particularly successful in landing contracts because of the quality and reliability of its drives, many analysts agree, is Quantum Corp.

"We have a Total Quality Control program that extends throughout the entire company," explains Ray Miller, vice president for quality and reliability. "The TQC program encompasses every department, including sales, marketing and accounting, as well as design, engineering and manufacturing."

Also, the design process includes three types of testing. Engineering verification testing and analysis verify the ability of the design to meet the customer's requirements and specifications. Design verification testing ensures that the drive will meet the specifications under all environmental conditions.

Finally, design maturity testing is performed prior to volume production to ensure that all aspects of the drive's operation, including its demonstrated MTBF, are within the acceptable range.

Quantum's manufacturing processes are equally rigorous, Miller says, and include constant testing, audits and functional reviews. The long-term reliability of the finished drives is verified through real-time sampling and testing that includes the continuous running of drives for four weeks and a total sample of 130,000 operational hours per month.

Quantum's ace in the hole, however, may be its partnership with Matsushita Kotobuki Electronics, which performs the bulk of the final assembly for Quantum. Furthermore, Miller notes that in the 3.5-inch sector, Quantum has shipped tens of thousands of drives, but fewer than 1,000 have been returned for rework or replacement.

"That level of quality is unheard of in the Seagate operation, which nevertheless offers good value for price in its marketplace," says Phil Devin, senior industry analyst at Dataquest Inc. He gives the Matsushita facility much of the credit for this success rate and notes, "Visitors to the Matsushita plant are often astonished to discover that the factory doesn't even have a rework area."

Miller credits Quantum's demonstrated product quality with tipping the balance toward the company in the competition for several large OEM contracts. In 1988, for example, the company signed major deals for its 3.5-inch drives with Tandy Corp., Commodore Business Machines Inc. and, most importantly, Apple Computer Inc. The $70 million Apple order followed an earlier Quantum contract with Apple to supply the PC vendor with 5.25-inch drives. ☐

Telecommunications controversy Down Under

Australia's telecommunications industry is undergoing deregulation, well, sort of . . . sparking controversy and cries of unfair play

BY CRAIG ADDISON

A string of commercial joint ventures at home has signaled a new era for Telecom Australia, the $6.1 billion national telecommunications carrier. Like AT&T several years ago, Telecom Australia will soon lose its government-blessed role as the monitoring body of the country's telecommunications industry. Under the newly deregulated market, Telecom Australia is free to compete in value-added network (VAN) products and services.

But by entering into commercial deals before it hands over its regulatory duties, the monopoly carrier has been accused of unfair play. [Editor's note: Telecom Australia is still the official telecommunications umpire, at least until the federal government establishes the independent Australian Telecommunications Authority (Austel), which won't be fully operational for at least another year.] And even when it does hand over umpiring duties, Telecom Australia will still own and operate the country's backbone communications network. Critics argue that this will give Telecom Australia considerable advantage over other competitors in the emerging VAN market, estimated at $77 million last year, according to Paul Budde Communications Pty. Ltd. of Sydney.

So far, Telecom Australia has invested $56 million in almost a dozen joint ventures, including two recent controversial deals with foreigners. One joint venture that caused a storm was the $11 million agreement struck with Hewlett-Packard Australia Ltd., which came under the scrutiny of the Australian Trade Practices Commission. The deal was allowed to go through, allowing Telecom Australia to offer communications and computer solutions, based on HP's products, to major corporate customers.

Telecom Australia's recent joint ventures

Joint venture (year established)	Shareholders	Telecom Investment
Advanced Network Management (1988)	Telecom Australia (60%) Systems Reliability (UK) (40%)	$350,000
Aussat (1984)	Telecom Australia (25%) Australian Government (75%)	$22 million
Telecom Hewlett-Packard (1988)	Telecom Australia (50%) Hewlett-Packard (US) (50%)	$11 million
Information Switching Technology (1988)	Telecom Australia (60%) Fujitsu (Japan) (40%)	$1.7 million
Natsoft Communications (1988)	Telecom Australia (50%) Merlin Communications (28%) Praxa (22%)	NA
QPSX Communications (1987)	Telecom Australia (60%) University of Western Australia (40%)	$5.4 million
Telecom-Messagetech (1988)	Telecom Australia (51%) Voicecall (49%)	$3.2 million
Telecom Technologies (1987)	Telecom Australia (50%) Exicom (50%)	$8 million

Conversion rate: Australian $1.14 = U.S. $1

Source: Telecom Australia

There were more cries of protest when Telecom Australia joined forces with Fujitsu Ltd.'s Australian subsidiary to design and manufacture ISDN PABX systems for local and international users. This deal effectively blocked out Telecom Australia's previous PABX suppliers — Siemens AG and NEC Corp. — and, perhaps most importantly, provided Telecom Australia with access to Fujitsu Australia's new $31 million manufacturing facility in Melbourne, Victoria.

A conflict of interest?

The HP and Fujitsu partnerships raised conflict-of-interest concerns by the Australian Telecommunications User's Group (ATUG). Executive director Wally Rothwell points out that while Telecom Australia is legitimately in the carrier business and has approval to compete in VAN services, many of the company's joint ventures are computer and communications manufacturing operations. Telecom Australia wields enormous buying clout and could favor equipment and services from its joint venture partners, at the expense of other suppliers, maintains the ATUG.

Telecom Australia's senior executives counter that joint ventures are a necessary strategy for survival and they refute claims that their control of the telecommunications network will result in an anticompetitive environment. Certainly Telecom Australia, with sales of $6.1 billion and a profit of $682 million last year, has the financial muscle to continue its joint venture activities. ☐

[Australian $1.14 = U.S. $1]

Military tragedies spur call to simulator firms

Accidents due to low-level NATO training missions mean West Germany is set to become the proving ground for next-generation flight simulators

BY BRUCE C.P. RAYNER

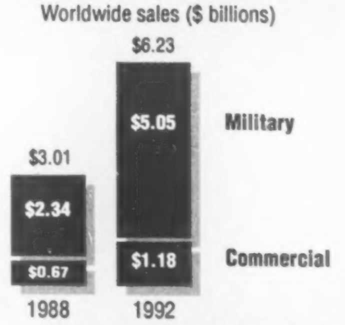
The West Germans have had enough. In the last year, more than 100 people, mostly German civilians, have been killed as a result of NATO air accidents. The worst accident was last August, when three Italian fighter jets collided at an air show at the U.S. Air Force Base in Ramstein, West Germany, killing 70 people. Not as disastrous but equally disturbing was a French Mirage F-1 accident last April near two nuclear power plants just 50 miles from Munich. And in February, six U.S. F-16s, based at Ramstein, came dangerously close to six passenger airliners over Frankfurt airport.

The central problem is low-level flight training. NATO insists its pilots need low-level training in Germany because this is where World War III would be waged. But critics counter that the cost in terms of lives and property has escalated to an unacceptable level. The alternatives are to conduct low-level flight sorties in remote areas — Northern Canada, Utah and Sardinia are all options — and to use high-technology flight simulators.

Political heat is spilling over into NATO troop movements too, the complaint being environmental damage. The 1989 U.S. Reforger troop exercises (Return of Forces to Germany) that were to take place in September, have been postponed until early 1990. The U.S. Department of Defense denies that politics had anything to do with the decision, claiming that it is simply a part of the new "training smart" philosophy at the DOD. However, the new philosophy conveniently involves using more simulators and less troops. All this is good news for simulator companies. What was a $2.3 billion worldwide military simulator market in 1988 is expected to grow at a 23% annual rate to $5 billion by 1992, forecasts Mark Lawrence, a technology analyst with Prudential-Bache Securities Inc. in Toronto and a simulator market watcher. Military training budgets will post a 35% growth rate while hardware expenditures will increase by 18% over the four-year period, he predicts. The United States accounts for about 75% of the total military simulation market.

Already there are signs of new business as a result of the political pressure. The German Ministry of Defense (MOD) has contracted with CAE Electronics GmbH of Stolberg, West Germany, a division of CAE Industries Ltd. of Toronto, to supply prototype low-level flight simulation capabilities for the German Air Force's Tornado fighter. Evans & Sutherland Computer Corp. of Salt Lake City is CAE's primary subcontractor and will supply the visual system image generator.

Simulation market



Source: Prudential-Bache Securities Inc.

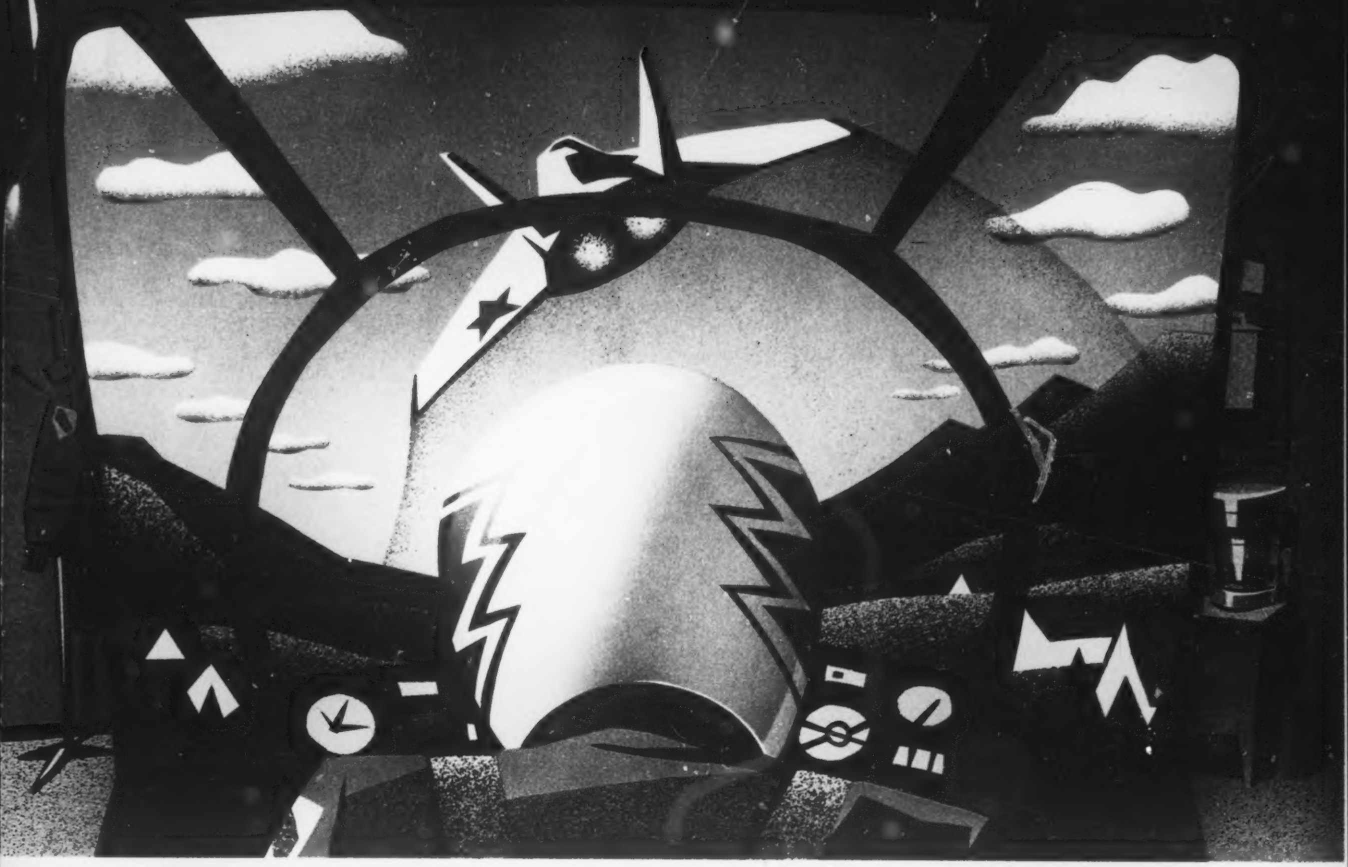
The U.S. accounts for about 75% of the total military simulation market

CAE has the largest military simulator market share in the world, followed by Hughes Aircraft Co. and Loral Corp., in that order, says Lawrence. Other major players include The Boeing Co., Evans & Sutherland, General Electric Co., IBM and McDonnell Douglas Corp.

The prototype phase of the CAE contract is valued at about $50 million, with evaluation expected to be completed by spring of 1991. If it meets with the MOD's approval, an order will be put out for seven more units with a price tag of about $300 million. This second phase involves modifying the existing seven Tornado simulators that the German Air Force uses so it can perform low-level flight training. Delivery is expected sometime in 1992 and 1993.

Because of such lucrative business, simulator companies on both sides of the Atlantic are consolidating their market positions through international acquisitions and teaming arrangements. The competition is expected to intensify as follow-on contracts to the Tornado materialize in the 1990s, pundits say. Already, the Germans are said to be in the market for an F-4 simulator and other NATO allies are watching closely. Even the United States is making overtures.

Last November, Brig. Gen. Bruce Lotzbire, the assistant director of operations for the U.S. Air Force in Europe (USAFE), took a swing through a few North American companies where simulators are made to see if they could be used for low-level flight training in Europe. But USAFE has so far concluded that available visual systems cannot currently replicate low-level flying at the tactical air speeds required for training, a USAFE spokesman says. However, "USAFE has been in contact with the German Armament Division in



Marty Braun

charge of testing the Tornado flight simulator prototype, and USAFE participation in the evaluation is a possibility," he adds.

If the political pressure in Germany spreads to other countries, simulator budgets will rise. And that $5 billion market figure for 1992 might end up being too conservative, says analyst Lawrence. What is more, Europe's relations with the Soviets are improving and NATO defense budgets will fall in the 1990s. In general, budget cuts bode well for simulators: it is cheaper to fly a mock-up of a Mirage or a B-1 than to take the real thing out on a training mission.

Other factors are playing on the European simulator industry as well. However, foreign defense firms are looking to increase their European business before intra-European trade barriers come down in 1992. Meanwhile, there has been speculation that a few of the big European defense firms — British Aerospace Plc, Messerschmitt - Boelkow - Blohm GmbH and Thomson-CSF — have discussed forming a stronger, more cooperative European simulation industry. Consequently, competition for simulators for new platforms like the European Fighter Aircraft and the French Rafale fighter aircraft will be stiff in the mid-1990s.

"In order for U.S. simulation companies to make a dent in Europe, they must team with European companies," says Robert Reed, executive director of the newly formed National Training Systems Association. Reed is a retired U.S. Air Force general, formerly the chief of staff at Supreme Headquarters, Allied Powers Europe. Major areas of U.S. contribution include processing equipment, imagery projection and digital land mass technology, according to Reed.

Military training budgets should post a 35% growth rate

Complement, not substitute

But can all this whiz-bang state-of-the-art technology *really* satisfy low-level flight testing requirements? According to most experts: no, it cannot. Simulators might complement but will never substitute for the real thing, they say. There is even the fear of negative training from simulators — a condition whereby pilots learn tricks in the simulators that, if used in the cockpit, might prove fatal. Also, air forces both in the United States and Europe fear that if they start budgeting for simulators, their planes will be taken away.

Former Navy test pilot Chuck Myers of Aerocounsel Inc. of Arlington, Va., insists simulators are inappropriate for training. "If you don't go out in the plane and do it," says Myers, "sitting in an electronic box won't do it." Myers recommends using cheaper planes for low-level training missions. But critics say cheap planes can hit buildings and nuclear power plants just as easily as expensive ones.

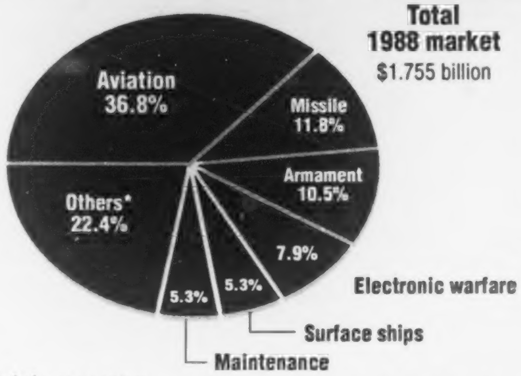
Still, simulators have their advantages. They can teach weapons delivery, instrument practice and emergency controls. These exercises are either too expensive to do in the plane or too dangerous to attempt. What is more, simulators can be used 24 hours a day.

There have been quantum jumps in the technology for visual systems in the past few years. At the Human Resources Laboratory (HRL) at Williams Air Force Base in Mesa, Ariz., Harold Geltmacher, chief of technology development at the operations training division, has been working on some of the stickier problems of simulation.

The HRL focuses on the technology to fill the gaps in the equipment currently available from contractors. Most of Geltmacher's work to date has centered around computer image generation and display systems — that is, how to create and project realistic images.

Some of the solutions that Geltmacher and his team worked on are the very ones the German air force plans to buy. In fact, the Germans will be the first to use this equipment for more than just R&D. The equipment includes a CAE-supplied fiber-optic helmet mounted display unit that gives the pilot a detailed "area of interest" picture through the eyepiece. That means that the resolution of the image is best at the center of the image, where the pilot's eye is focused, but deteriorates at the edges.

U.S. military simulation spending



* Includes non-system specific training devices

Sources: Frost and Sullivan Inc., Prudential-Bache Securities Inc., ELECTRONIC BUSINESS

According to Jack Derwett, manager of General Dynamics' R&D flight simulation laboratory in Fort Worth, Texas, the area-of-interest simulator is "the way of the future." And what the Germans are buying will be one of the most sophisticated simulation systems in the world.

"The technology is well advanced, but it is not complete," adds Peter Gramson, the new business manager for military simulation at British-based Rediffusion Simulation Inc., a Hughes Aircraft firm. He estimates that the current state-of-the-art simulator is about 70% to 80% of what is needed.

While most of today's research and development is going into improving the fidelity of the computer-generated image, other areas have lagged behind, Gramson comments. For instance, understanding the psychology of how and why pilots respond to certain stimuli in the cockpit, called queues, is still an area that requires attention. At the HRL, says Geltmacher, understanding queues is a major area of interest.

Acquisitions and teaming

Not surprisingly, international acquisitions and teaming arrangements have been running rampant. Heavyweights such as British Aerospace, CAE Industries and Hughes Aircraft have all made international simulation acquisitions in the last year. Others have gone the teaming route. For instance, General Electric, a leader in vision systems with its CompuScene IV system, has teamed with Germany's Messerschmitt-Boelkow-Blohm.

One cause of the acquisition binge is the demand by the military — mainly the U.S. Department of Defense — for total training systems, that is, delivery of all services necessary for training a pilot. These include simulators, training manuals, courses and testing. The idea is for the contractor to supply a totally trained and guaranteed pilot. At present, CAE is the only company that offers this total training option.

One cause of the acquisition binge is the military's demand for total training systems

Although most of the big simulation players have changed hands, a few important acquisition question marks remain. One is Evans & Sutherland, one of the two leading international suppliers of top-of-the-line vision systems, the other being GE. However, it is Evans & Sutherland's ESIG 1000 systems that the Germans will be purchasing.

The $130 million company would be a natural fit for any of the big aerospace companies involved in simulation or interested in entering the market, say analysts. Of course, that includes most of the world class defense players.

Even though Evans & Sutherland is not currently on the market, its stock is widely held and its technology is in hot demand. Likely U.S. suitors include Loral and any one of the major air frame makers including Boeing, Hughes or McDonnell Douglas, says Prudential-Bache's Lawrence.

Boeing supplies the Air Force with B-1 simulators; Loral supplies an F-15E trainer; and McDonnell Douglas supplies simulators for the F-14D and the A-6F. Hughes has its fingers in a lot of pies. Last April, it paid $270 million for Rediffusion Simulation, which supplies about 40% of Britain's military simulator contracts, and late last year it paid about $100 million for Honeywell Inc.'s Training and Control Systems Division.

Even CAE Industries might be interested in Evans and Sutherland. The $750 million company has divisions in Britain and West Germany and last year entered the U.S. military market by purchasing four Link simulation and training divisions from Singer Co. for $550 million. Although Link Flight Simulation, one of the U.S. divisions, has its own vision system, experts say the Evans & Sutherland ESIG 1000 technology is more advanced.

Foreigners would be interested in Evans & Sutherland, too: Thomson-CSF, the French military electronics giant, is one potential suitor. Last year, Thomson lost out to Hughes in its purchase of Rediffusion and withdrew its offer for Link-Miles, a Singer division still owned by Paul Bilzerian, the corporate raider who took control of Singer early last year. However, pundits say the Pentagon would not look favorably on foreign ownership of such advanced technology. But then the Department of Defense did not complain when CAE Industries bought Link. ☐

A vision is fulfilled: VSATs flourish — finally

The hype and hope years have ended. VSAT applications are materializing and prices are falling, to the delight of wide area datacommunications users

BY ANNE KNOWLES

It has taken longer than expected, but the market for very small aperture terminals, or VSATs, is finally living up to its predicted potential. The technology — touted as the answer to corporate America's wide area datacommunications needs since early in the decade — has had its kinks ironed out, say VSAT manufacturers and service providers. Costs have dropped and more applications have materialized. Now, the small satellite earth stations are popping up everywhere.

VSATs, small, software-intensive earth stations designed primarily for data and video communications, are easily and quickly installed. They allow users to reconfigure their wide area communications networks more quickly than a network based on phone lines. That gives the user greater control.

The U.S. VSAT market, which accounts for the lion's share of today's worldwide market, more than doubled last year. The U.S. market grew from $63.2 million in 1987 to $151.4 million in 1988, according to Dataquest Inc., a market research firm in San Jose. This year, the market should hit $193.3 million, Dataquest projects, and continue to register about 40% compound annual growth for the next four years, until it reaches an estimated $493.3 million in 1992.

There are between 10,000 and 13,000 VSATs currently installed worldwide, says Frank Connors, president and CEO of Satellite Technology Management Inc. (STM), a VSAT equipment supplier in Costa Mesa, Calif. But there are between 25,000 and 30,000 VSATs on order throughout the industry, Connors says. That is about two to three times the installed base.

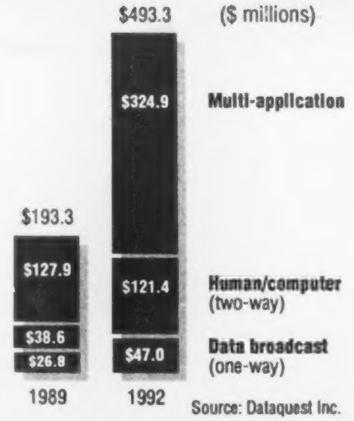
Manufacturers originally marketed VSAT networks as a cost-effective, flexible alternative communications media for remote location communications. The reality, however, was neither cost effective nor flexible.

Early systems inflexible

Combining the satellite-based technology with existing packet-switching technology also presented more hurdles than early vendors owned up to. That led not only to delays, says Roberta Wiggins, senior analyst with The Yankee Group in Boston, but it also destroyed user confidence in VSAT technology. In addition, more mundane problems, such as having to secure landlord permission to install rooftop VSATs, led to further delays and frustrations.

"Early systems met only one or two specific applications," says Bill Hogan, network systems group marketing manager at Scientific-Atlanta Inc., a VSAT manufacturer in Atlanta. "They were very inflexible and the costs were high. Early companies sold on a lot of promises and it took a long time to work through the problems." But in the last year, says Hogan, "the bugs have been worked out."

U.S. VSAT market



Source: Dataquest Inc.

The U.S. VSAT market should register 40% annual growth over the next 4 years

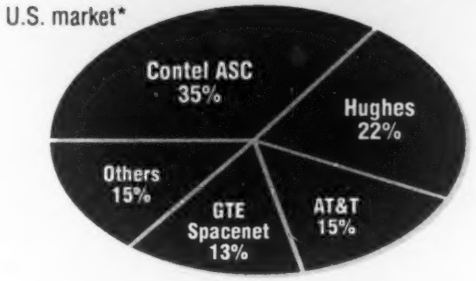
Prices have also dropped. Three to four years ago, says Hogan, a remote VSAT, equipment only, cost about $15,000. Today, that same system, says Hogan, is priced between $10,000 and $11,000. Most manufacturers and analysts agree that VSATs now cost between 20% to 50% less than the same application run across leased phone lines. Most participants also agree prices are beginning to stabilize and will drop less dramatically in the coming years.

Increasingly, VSATs are replacing existing phone lines in major metropolitan areas. "Almost every VSAT out there," says R. Gary Mesch, vice president for marketing and sales at Nova-Net Communications Inc., a turnkey supplier of VSAT networks in Englewood, Colo., "is installed to replace leased lines."

Subsequent large contracts also have rekindled user confidence. Chrysler Corp., for example, has 6,000 VSATs installed and buys them from Hughes Communications Inc., a VSAT supplier owned by Chrysler competitor General Motors Corp. K mart Corp., the retailer, was an early adherent to VSAT technology that, despite snafus, continued its contract with GTE Spacenet, the satellite communications division of GTE Corp., for a private data and video network for its 2,100 stores.

While the market has been steadily growing, the industry itself has been in flux. Players have come and gone. Some companies dropped out of the market after making promises they

Top U.S. VSAT vendors



Total 1988 market: 25,000 VSATs

* For VSATs installed or on order

Source: The Yankee Group

couldn't keep, says Philip Arcoria, marketing manager for NEC America Inc.'s satellite communications systems division. Other companies have spun off. Vitalink Communications Corp. in Fremont, Calif., for example, spun off its VSAT division, now called Vitacom Corp., in order to concentrate on its wide area and local area network business, says Bruce Bell, vice president for operations at the employee and venture funded Vitacom.

But most of the name changes have been because of acquisitions. Early entrants in the market were start-ups that could not survive the large capital investments alone, says Yankee Group's Wiggins, and thus began looking for buyers. Larger corporations, looking for existing technology, bought their way into the market.

Contel Corp., Atlanta, bought American Satellite Co., turned it into its network and satellite division called Contel ASC, which in turn acquired Equatorial Communications Co., making Contel ASC the largest VSAT supplier. Hughes bought M/A-Com Inc.'s VSAT operations, giving Hughes the second largest market share in 1987, according to Dataquest. Scientific-Atlantic acquired Adcom, giving the Atlanta-based supplier a place on the top 10 list of VSAT equipment and service suppliers.

Last year, AT&T took a large step forward in VSAT market share when it acquired Tridom Corp., a Marietta, Ga., VSAT manufacturer. The telecommunications giant then purchased Harris Corp.'s Pactnet satellite ground station technology in November.

The acquisitions binges are because of a trend in the market for one-stop shopping, according to Steve Sazegari, a telecommunications analyst with Dataquest. Sazegari expects to see more acquisitions because the strategy in the industry is to integrate VSAT hardware with full satellite service support. That way, customers can then turn to one vendor to lease satellite time, lease or purchase a network hub, buy VSAT equipment, software, service and network management.

Despite that, and industry-wide agreement that customers prefer one vendor to many, the handful of players in the market have different strategies. GTE Spacenet, for example, does not manufacture VSATs; the company buys NEC hardware. But GTE Spacenet does everything else, including selling the systems with proprietary software and leasing time on its own satellites.

"The VSAT is just one small part of it," says Ray Marks, vice president for marketing at GTE Spacenet. Also, the hardware component carries the lowest margins. The hardware, says Marks, "is probably less important than having the infrastructure to provide support, service and network management." For that reason, says Marks, GTE Spacenet will not become a manufacturer and will not acquire one.

Increasingly, VSATs are replacing existing phone lines in major metropolitan areas

NEC, on the other hand, only sells to original equipment manufacturers. "NEC is a quiet company," says NEC's Arcoria. "We like to stay away from the end user. It has worked in the past in other areas." Last year, the company, which has about 2,000 VSATs installed and counts 10,000 more on order, signed up six OEMs, including Nova-Net, which also resells Contel ASC and Hughes equipment.

Nova-Net, like GTE Spacenet, does everything but manufacture. Nova-Net's Mesch says there are three types of suppliers in the industry: manufacturers, such as NEC, that do not provide service; manufacturers, such as AT&T and Hughes, that provide systems and service; and turnkey suppliers such as Nova-Net that do not manufacture but supply end users with complete service.

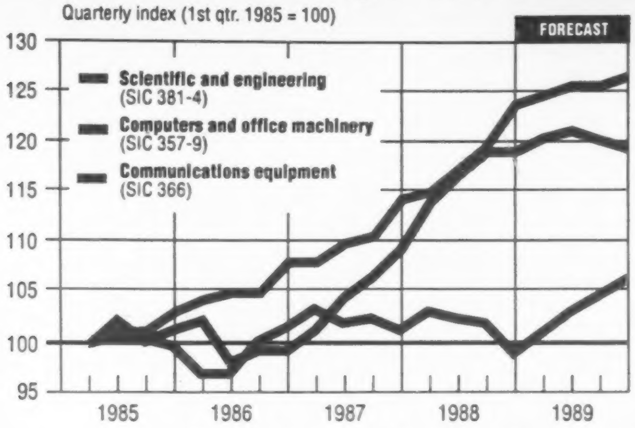
Another way to segregate it is by end user. Most VSAT service providers target large end users, such as Chrysler. Nova-Net, which has targeted the energy industry, also focuses on the small user with under 500 sites to service. Those customers, Mesch has found, are increasingly interested in leasing, rather than buying, the equipment and services.

The small customer is becoming a bigger segment of the market, says Yankee Group's Wiggins. The large end-user segment is near saturation, says Wiggins, and the greatest growth in the market over the next few years will be with smaller end users.

The market outside the U.S. is also expected to take off in a few years. Specifically, post-1992 Europe should see rapid growth, says Yankee Group's Wiggins and others, when deregulation of the telecommunications industry hits Europe the way it hit the United States five years ago. VSAT network suppliers are making arrangements in Europe. Hughes, for example, sells through a distributor owned by West Germany's Daimler-Benz AG and Satellite Technology Management Inc., a VSAT service provider in Costa Mesa, Calif., has a pilot system at West Germany's Postal, Telegraph and Telephone agency.

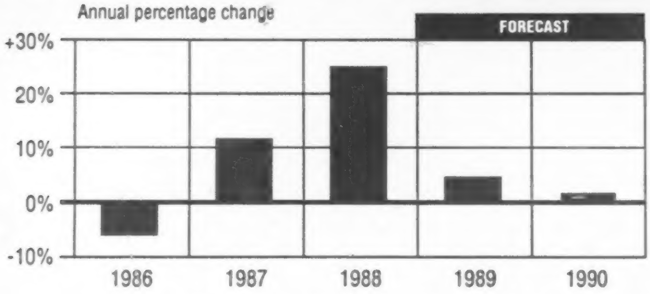
Those markets will become increasingly important, says Yankee Group's Wiggins, as VSAT networks evolve. Tomorrow's VSAT networks, says Wiggins, will succeed as part of a hybrid system including satellite and fiber-optic communications into one network. ☐

Instrument production steadily rises



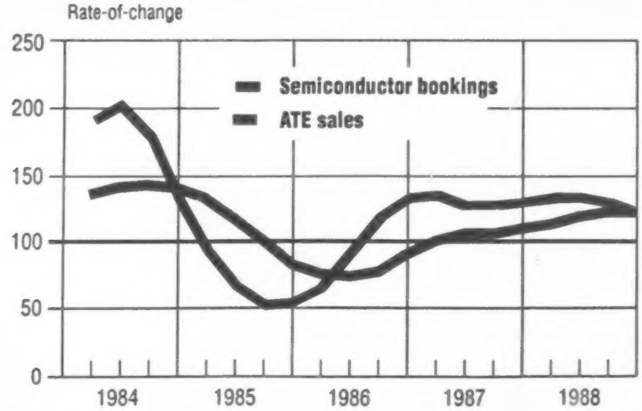
Historical data: Federal Reserve Board; Forecast: Cahners Economics

Automatic test equipment sales



Historical data: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Semiconductor bookings versus ATE sales



Historical data: Semiconductor Industry Association, ELECTRONIC BUSINESS

Production stays on a steady growth path

Manufacturers of instruments and controls continued to churn out ever-more units during 1988. Average annual production in this industry increased 7.5% from the level in 1987. As a consequence, capacity utilization rates climbed, hitting 83.6% in October of last year. That was the highest monthly rate since the beginning of 1985.

Even with an impending slowdown in business investment growth, generally a driving force for gains in the test instruments and process control markets, the instruments industry is expected to make steady headway in 1989 and 1990. At least two of the big buyers of process controls, the chemicals and paper industries, operated at utilization rates brushing 90% or above. These industries are still busy modernizing plants and adding new capacity, and therefore, buying more equipment.

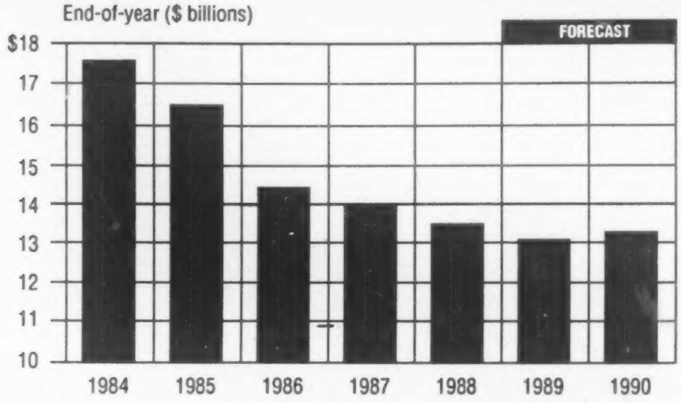
Since 1985, production gains in the instruments and controls industry have outpaced those in both the computer and communication equipment sectors. One reason is that instruments manufacturers did not suffer the pronounced slowdown in 1986 as did other electronic equipment makers. In fact, only during the 1975 and 1982 recessions did production of instruments actually decrease.

On the automatic test equipment front, the ELECTRONIC BUSINESS ATE Sales Index jumped to an estimated 888.0 (1976 Q1 = 100) in the fourth quarter of 1988 from a revised 836.1 in the third quarter. For all of 1988, the index shot up about 25% compared with the prior year. In dollar terms, the percentage gain brought worldwide sales to $2.24 billion in 1988. Sales are forecast to increase again, just under 5%, this year. This slower growth is in response to the contraction in semiconductor orders.

Monitoring business cycle developments in the semiconductor industry can give ATE manufacturers some early warning of expansions or contractions in their industry. The business cycle curve for semiconductor bookings (a plot of the rate-of-change values) has consistently led the curve for ATE sales during the entire 1984 through 1988 period. More importantly, it has given three to six months early warning of the last three business cycle turning points in the ATE industry.

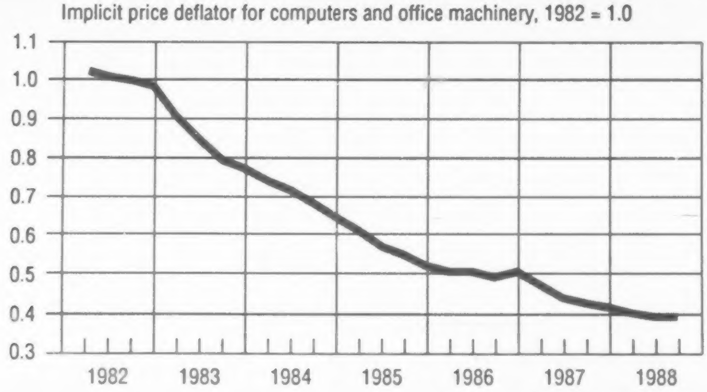
MADELINE FRANCHI

Computers and office machinery — Unfilled orders



Historical data: U.S. Department of Commerce; Forecast: Cahners Economics

Computer and office machinery prices are down



Historical data: U.S. Commerce Department

Shrinking backlogs a disturbing indicator

Although shipments of computers and office machinery grew almost 11% in 1988, the best year for growth since 1984, backlogs never recovered from their most recent plummet. At the end of 1984, unfilled orders for computers and office machinery tallied $17.6 billion, just about even with the year before. But, since 1985, the value of backlogs has been shrinking. Backlogs have steadily dwindled from $16.5 billion in December 1985 to just $13.5 billion at the end of 1988.

Because values are measured in current dollars, some decline might be expected. Prices of computer hardware have eroded over the past several years and the industry composition has shifted from mainframes to desktop computers. According to U.S. Commerce Department data, the implicit price index for computers and office machinery shrank by a little more than 10% just from the third quarter of 1987 to the same period in 1988.

Nevertheless, the fact that unfilled orders did not recover from the last downturn is disturbing. The industry does not have a large buffer to work off as growth in new orders for computer hardware and office equipment slows down this year.

MADELINE FRANCHI

Computer market database

Latest quarter: 4th quarter 1988	Latest quarter	Previous quarter	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, qtr. average)	320.3	319.0	+0.41%	293.6	+9.09%	320.5	+0.06%
Shipments (SA, $ millions, qtr. total)	$16,721	$17,406	-3.94%	$15,367	+8.81%	$16,742	+0.13%
New orders (SA, $ millions, qtr. total)	$16,480	$17,306	-4.77%	$15,204	+8.39%	$16,808	+1.99%
Unfilled orders (SA, $ millions, qtr. total)	$13,479	$13,720	-1.76%	$13,951	-3.38%	$13,059	-3.12%
Inventory-to-shipment ratio (SA, end of qtr.)	2.18	2.04	—	2.08	—	2.20	—
All employees (thousands, end of qtr.)	525.0	517.8	+1.39%	501.1	+4.77%	516.4	-1.64%
Production workers (thousands, end of quarter)	171.3	167.4	+2.33%	169.3	+1.18%	165.9	-3.13%
Exports ($ millions, qtr. total)	$6,266	$5,596	+11.98%	$5,419	+15.63%	$6,353	+1.39%
Imports ($ millions, qtr. total)	$6,310	$5,759	+9.56%	$5,719	+10.33%	$6,866	+8.82%

SA = seasonally adjusted, all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

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Electronic Business®

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE MAY 1, 1989

RAISING SUN

McNealy cultivates the growth leader PAGE 24

100 Fastest growing U.S. companies PAGE 34

Top U.S. firms in Japan PAGE 68

Nealy,
dent and CEO

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 15, NO. 9 MAY 1, 1989

PAGE 24 Sun CEO Scott McNealy cultivates the growth leader

COVER STORY/STRATEGIES

24 Raising Sun: McNealy cultivates the growth leader

Sun Microsystems is the undisputed U.S. sales growth leader for the second year running. Racing along at a blistering pace with a five-year compound annual rate of 161%, Sun again tops our list of the 100 fastest growing U.S. electronics companies. All along, CEO Scott McNealy has managed Sun's growth with two parts freewheeling style, one part courage, and a generous helping of luck. But now, as Sun keeps on growing, tight operating disciplines are beginning to temper the zealous growth religion that once dominated.

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17 Making college hires productive sooner

National Semiconductor has a "boot camp" assimilation program that teaches new recruits toughness, networking and loyalty. The aim of the pricey program is to shape National's next generation while keeping the headhunters at bay.

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Who makes ELECTRONIC BUSINESS' list of the top 100 fastest growing companies? The conditions are simple: all must be publicly held, show six years of sales results to be compounded annually for five years of growth, and have reached $750,000 in sales in their first year.

24 Raising Sun: McNealy cultivates the growth leader

There's no magic to Sun's success story, so says CEO Scott McNealy. Only the usual things, like "Getting enough sleep, thinking clearly, being lucky, working harder than anyone else." But, still, there must be magic: 7 years old and eyeing the $2 billion sales mark.

34 Facts behind the figures and the fastest growing U.S. companies

Sun is joined in the ELECTRONIC BUSINESS listing of the 100 fastest growing U.S. electronics companies by Oracle, 3Com, Novell and AST Research, respectively. In addition to the comprehensive top 100 listing, we also include a listing of the fastest growers by industry segment and other data that lend perspective.

45 Growth master Conner ramps for doubling of shipments

The mini-drive maker has already broken first-year sales records of its fast-growing top customer, Compaq. Tight ins with vendors may help win more glory. Flamboyant founder Finis Conner admits, though, that managing the company's rapid ascent has been no easy task.

47 TeleVideo: A lesson in how not to grow fast

Revenue from the maker of PCs and terminals is nothing like the old days of '83 when it was heralded as one of the growth masters. For TeleVideo, it's a story of how growth went negative. But there have been changes that point to the goal of getting back to the black.

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Technology consultant Regis McKenna says a "knowledge to implementation" gap means managers of high-growth companies must know what to do, and then move fast.

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68 U.S. firms in Japan finally cash in on the weak dollar

Revenue increased 32% for the big U.S. electronics makers in Japan in '88. The returns are even better than those for most of the local Japanese firms. The strong Japanese domestic market, favorable exchange rates, and, yes, pressure to buy American have helped.

Cover illustration: Daniel Kirk

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Flat '89 sales will kill small distributors, too. But the diehards plan survival by buying in teams, upping quality and niche selling. Insiders say, for the most part, the survivors will be those distributors who lower their operating expenses.

80 Savvy Brits snap up small U.S. distributors

The British are coming. No, too late, they're already here. British distributors like Electron House are already building new empires — with an emphasis on leaner organizations and higher profits.

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Booz, Allen & Hamilton consultants offer that better margins come to those that target their markets best and team well with suppliers — adding that increased gross revenue is not a guarantee for bottom-line performance.

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98 Setting up global telecom networks that work

Instant communication is a prerequisite for electronics firms competing in a global marketplace. The key is to link up in a cost effective manner: you may not want to put a network in where you can't get a dial tone.

109 International directory of plant sites and facilities

The ELECTRONIC BUSINESS international directory of plant sites and facilities offers a beginning for electronics companies seeking an initial contact in foreign countries, where the rules are often different.

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Growth spurt

If, in centuries to come, the electronics industry is to be remembered for anything special, it may well be remembered for the outrageous growth rates of its earlier days. The Apples and Compaqs and Suns are already legends in their own corporate lifetimes, and their fresh-faced founders and senior executives have become the new heroes of the business world.

ELECTRONIC BUSINESS caught on early that there was significance in using sales growth rates as measurements of performance — measurements that had almost as much cachet as sales and profit figures themselves. Some years ago, senior editor Linda Stallmann — she's the editorial heroine who plows through more annual reports than most people have had hot dinners — began the Sisyphean task of dissecting the data and averaging out five-year compounded annual growth rates.

Over the years, we've dug deeper into the league tables of figures that we've run. Linda analyzes them to produce some intriguing findings: which U.S. electronics industry sectors are hottest, which U.S. states are home to the most fast-growing electronics companies, that sort of thing.

But this year, we've worked harder to unearth a few more gems. Extra interpretations of some of the numbers, showing, for example, that the U.S. electronics industry is regenerating itself in a very healthy way.

Around the tables of fastest growing firms, we've built some powerful editorial that scrutinizes how some particularly fast movers have managed — and how others have mismanaged — their revenue growth.

Linda Stallmann, senior editor

Our excellent cover story by associate editor Barbara Berkman — how Scott McNealy kept Sun on track — makes compelling reading.

The British are coming!

That's the scoop from senior editor Bruce Rayner, whose investigations show that one or two major British distribution houses believe they can do it better than their U.S. cousins. One result: the Brits seem intent on acquisitions of U.S. regionals to prove the point. But as Bruce points out, they won't find that every little regional distributor is a pushover. To get control of their operating costs, many of the little guys are mounting impressive quality programs and some are even teaming to buy parts in bulk. That's the way to do it.

JOHN KERR, editor

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BPA ABP

Electronic Business

The fastest growing U.S. electronics companies

Top 10 fastest growing companies

1988 rank	Company	Five-year sales growth	Fiscal 1988 sales ($ millions)
1	**Sun Microsystems**	161.2%	$1,051.6
2	**Oracle Systems**	123.7%	282.1
3	**3Com**	121.3%	251.9
4	**Novell**	118.3%	281.2
5	**AST Research**	100.6%	412.7
6	**Symbol Technology**	88.0%	89.0
7	**Micron Technology**	87.0%	300.5
8	**Mark IV Industries**	79.6%	403.0
9	**Compaq Computer**	79.4%	2,065.6
10	**Ashton-Tate**	76.2%	307.3

What's inside

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Sheer sales volume is impressive by any count, and if that revenue intake is accompanied by consistently large profits, then the company is deemed a success.

But the unique history of America's electronics sector has produced a third register of success: rate of sales growth. Just look at the awe that Compaq Computer Corp.'s track record commands: can a company that hurtles from nothing to more than $2 billion in sales in seven years be considered anything but a hit?

By hitting $111 million in sales for its first full year of business, Compaq became not only the fastest-growing company in the history of electronics, but in the history of American business. And it helped establish revenue growth as a valid performance gauge. It also helped create awareness that the management of that growth makes many other executive challenges look like child's play.

ELECTRONIC BUSINESS recognized the value of a fast-growth measure four years ago, and launched what has become one of its most eagerly read features: its league tables of the top 100 fastest-growing U.S. companies.

The conditions are simple: the companies must be publicly held and U.S.-based, and must show six years of sales results because the figure we use is compounded annually for five years of growth. And in their first year of business, they must have reached at least $750,000 in sales (clearly, the smaller the first-year sales, the higher the growth rate. One dollar in first-year sales would produce a ridiculously high figure).

By those criteria, revenue racers such as disk-drive maker Conner Peripherals Inc. (which last year beat Compaq's first-year growth record) and PC powerhouse Dell Computer Corp. don't make our formal list.

This year, as usual, we break down the data by segment to show which industry areas were hot and which less so. But we're taking the analysis a step further, unearthing facets that we feel are of considerable interest. We examine IBM's position in the tables; look at which states hosted the most fast movers; analyze why some companies climbed the rankings while others slid, and much more.

A few snapshots: most of the top 10 are computer or computer-related companies. Three of the 10 —Sun Microsystems Inc., Oracle Corp. and AST Research Inc. — are back, showing that they understand the rudiments of growth management. And two of the newcomers to the list — 3Com Corp. and Novell Corp. —show up as the fastest of the fastest, racing along in the PC connectivity rush.

The listings are complemented by the cover story which is much more of an object lesson than a company profile. To the surprise of few, workstation supremo Sun hits the No. 1 slot for the second year running. Which raises the compelling business question: how exactly did chief executive officer Scott McNealy and crew manage it?

Managing growth, then, is the focus of this and the other strategy stories in the fastest growing section. And to round it off nicely, there's are a few tips on growth management from the man who helped Intel Corp. and Apple Computer Inc. do it faster and better: Regis McKenna. ☐

Daniel Kirk

STRATEGIES

FASTEST GROWING COMPANIES

Raising Sun

Sun is the undisputed U.S. sales growth leader for the second year running. Managing that growth has been, for CEO Scott McNealy, two parts freewheeling style, one part courage and a generous helping of luck. But as Sun keeps on growing, tight operating disciplines are tempering the zealous growth religion that once dominated

BY BARBARA N. BERKMAN

A morning of speech-making has left Scott McNealy tired, with no hint of the fraternity boy exuberance or *wunderkind* cockiness usually linked to Sun Microsystems Inc.'s top management. A 34-year-old chief executive who boasts about skipping one-half of his business school classes at Stanford, McNealy flashes slight impatience as a visitor asks him to analyze Sun's own management: How has McNealy managed the internal growth of a company that has raced along at a blistering five-year compound annual growth rate of 161%?

McNealy barks off his answer. "Look, the most difficult things to do when you're running a company are getting enough sleep. Thinking clearly. Having the courage to make tough decisions. Being lucky. Working harder than anyone else. There's no magic to it."

But there is a magic to Sun. Under McNealy, Sun has become one of Silicon Valley's more remarkable success stories. After only seven years, Sun has positioned itself as the workstation industry leader and seen sales approach the $2 billion mark. In the first half of the 1989 fiscal year ended June 30, Sun had a net income of $50 million on revenue of $837 million. Fueling Sun's growth was its early recognition of industry trends: the move away from proprietary host-based computer systems toward networks of desktop computers incorporating open industry standards.

Silicon Valley's Tom Hanks

But Sun's most astonishing performance has been offstage: managing the support systems that have kept the company from cracking under the tremendous stress of growth. Sun shot into a behemoth while still in its gangly adolesence, a Tom Hanks in Silicon Valley's own version of "Big." Says McNealy: "Sun is like a 7-foot-3-inch 13-year-old." McNealy's colossus exists because of his single mission for Sun: grabbing more market share. What McNealy values is the institutionalization of growth.

"From day one, it was an understanding that they'd be a multibillion dollar company, or they'd fail totally," says Stanley M. Davis, a Boston-based author who is writing a Sun-sponsored book on the information society. McNealy's "explicit vision," says Davis, has been, "we have to be big fast, or fail."

Sun has yet to hit the hurdles that would trip its nonstop growth. Observers, though, say those hurdles will come soon for the Mountain View firm, as Sun faces hotter competition — especially from a Hewlett-Packard Co. emboldened by its Apollo Computer Inc. buy — margin pressure for its new low end sub-$10,000 products and a continuing battle to win acceptance for its Sparc processor design.

Managing Sun for the past seven years has been managing change. At various points, Sun has outgrown its staff's capabilities, its MIS system, its phone system, its facilities, its marketing and customer support. Outside observers have watched Sun do battle with its competitors and wrestle away market share each year. But internally, Sun waged its own private campaign to keep from being crippled by its own life support systems. Several Sun botched, including:

- An MIS system appropriate for a company one-quarter Sun's size;
- Lax fiscal controls that let inexperienced managers run departments like autonomous fiefdoms;
- Inadequate allocation of resources to customer support.

Yet Sun has certainly managed many aspects of its internal growth well, or it wouldn't top ELECTRONIC BUSINESS' list of fast-growth companies. Its best accomplishments:

- Assimilating hordes of outsiders into Sun's fast-growth culture;
- Intuitive timing in raising capital;
- In manufacturing, curtailing capacity to keep up with quality control; farming out manufacturing; whittling down the number of suppliers to around 100.

Why did Sun pinch pennies on customer service and information systems? McNealy never stepped back from allocating resources to technology, typically spending 12% to 14% of revenue on R&D. That hefty allocation to technology has left a much smaller slice of the resource pie for operating expenses.

Grabbing a Magic Marker, McNealy moves from a small round conference table to the one white plastic wall of his office meant for impromptu illustrations. He draws a chart with two rising lines: one is revenue, the lower one is operating expenses. His point is obvious: While Sun's revenue has doubled in some fiscal years, if McNealy proportionately allocated twice as much to operating expenses, Sun would run at a loss. "It's a horrible tightrope. Running a company is finding out what you can afford not to do," says McNealy. For seven years, McNealy and Sun have been making do.

The result: Sun underinvested in support. "Hundreds of crises we solved internally. We never hit the wall. But we had quality problems, customer problems, every problem you could ever imagine," says David Marquardt, a Sun venture capitalist with TVI Management, and a director since 1982. "MIS turned out to be an almost crippling thing to the company later on," he adds.

> **"Look, the most difficult things to do when you're running a company are getting enough sleep. Thinking clearly. Having the courage to make tough decisions. Being lucky. Working harder than anyone else. There's no magic to it."**
>
> **—Scott McNealy**

Fighting MIS fires

While Sun fought other fires, investment in systems went overlooked. In 1983, as a $9 million company with some 90 employees, Sun installed an MIS system using Ask Computer Systems software run on a Hewlett-Packard Co. model 3000 computer. For a company of that size, it was a fairly costly investment of about $1 million. But Ask software is targeted for companies of not more than $500 million, and as Sun grew, it was forced to split databases until abandoning the system entirely in April. (Sun replaced the MIS, at an estimated investment of $15 million to $20 million.)

Was McNealy's choice of MIS a sign of short-range planning or fiscal conservatism? Crawford Beveridge, vice president for human resources, argues the latter. "We're just now being weaned off the HPs. In fact, that's taken us to a $2 billion company. It was an amazingly forward-thinking decision."

Still, Sun has lived with the consequences of McNealy's 1983 selection for six years. "There are times our MIS system is ready to explode because of the order rate," observes Edward Zander, Sun's marketing VP recruited from arch rival Apollo Computer Inc. in 1987. "And the telephone, which was ready to blow up with the trunk lines in here. . . . But we haven't blown a fuse yet."

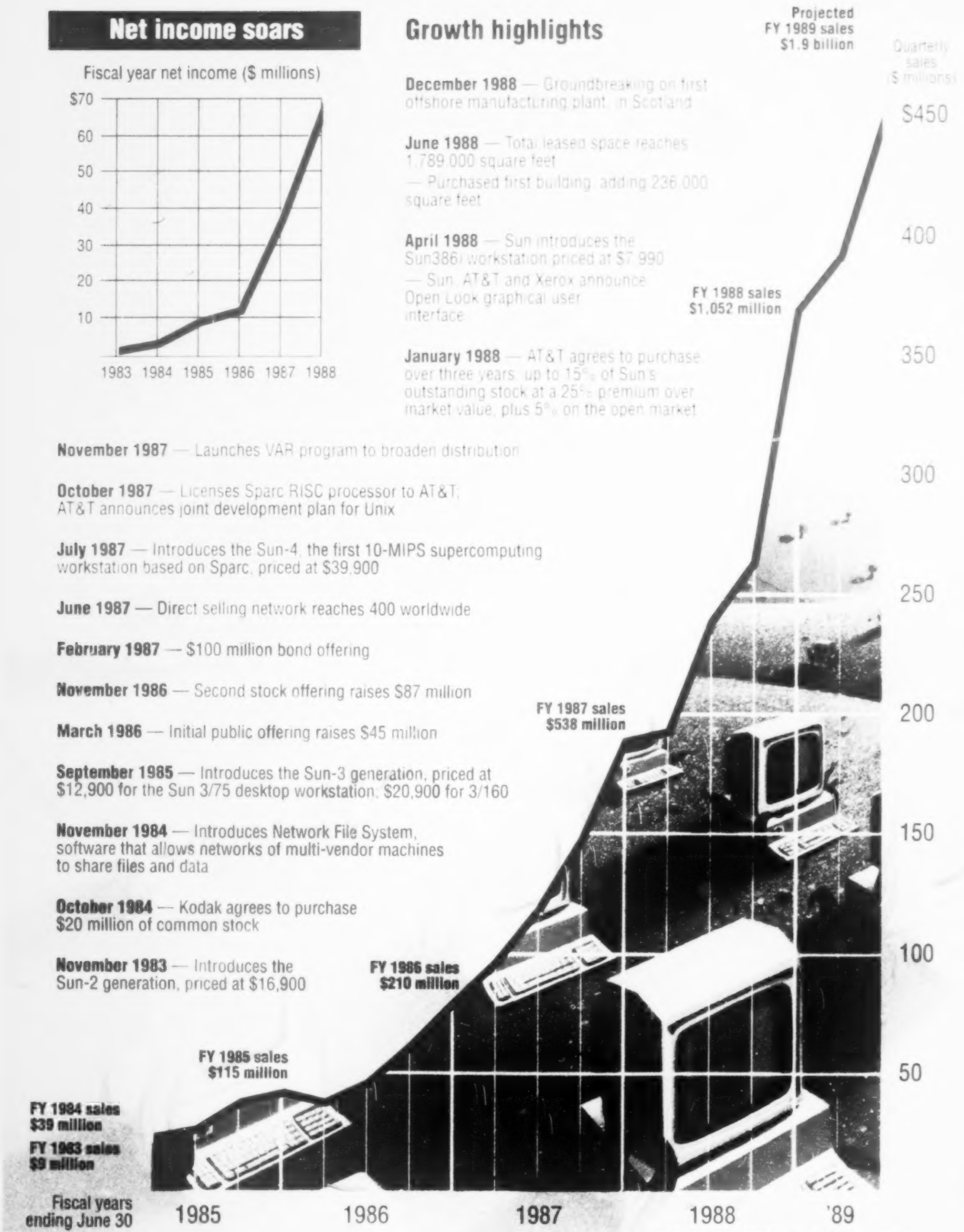
Growth problems have plagued McNealy since he cofounded Sun in 1982 with Vinod Khosla, who retired some two years later; software genius Bill Joy, now vice president for R&D; and Andreas Bechtolsheim, who remains as Sun's vice president for technology. Only Khosla, a founder of Daisy Systems Corp., had been through the demands of managing a fast-growth company.

McNealy joined Sun as head of manufacturing. What McNealy and company learned about management they absorbed in two ways — by making mistakes, and by bringing on experienced managers from Digital Equipment Corp., as well as from Sun rivals Apollo and Apple Computer Inc. The most senior was Bernard Lacroute, arriving in 1983 from DEC. He is now Sun's executive vice president, a powerful back-room presence to McNealy's exuberant style.

Mixture for success

Oddly, the amalgam of corporate cultures mixed well at Sun. From the start, McNealy encouraged participatory management that allowed quick-fire decision making. "After the $100 million mark, we see the role of Scott changing from entrepreneur to manager. Scott did a very good job of letting go of the details. He was a beacon [of Sun's culture], spreading 'this is what my company is built on,' " says John Dunkle, vice president of WorkGroup Technologies in

Sun Microsystems: From small workstations mighty systems grow



Net income soars

Growth highlights

December 1988 — Groundbreaking on first offshore manufacturing plant, in Scotland

June 1988 — Total leased space reaches 1,789,000 square feet

— Purchased first building, adding 236,000 square feet

April 1988 — Sun introduces the Sun386i workstation priced at $7,990

— Sun, AT&T and Xerox announce Open Look graphical user interface

January 1988 — AT&T agrees to purchase, over three years, up to 15% of Sun's outstanding stock at a 25% premium over market value, plus 5% on the open market

November 1987 — Launches VAR program to broaden distribution

October 1987 — Licenses Sparc RISC processor to AT&T; AT&T announces joint development plan for Unix

July 1987 — Introduces the Sun-4, the first 10-MIPS supercomputing workstation based on Sparc, priced at $39,900

June 1987 — Direct selling network reaches 400 worldwide

February 1987 — $100 million bond offering

November 1986 — Second stock offering raises $87 million

March 1986 — Initial public offering raises $45 million

September 1985 — Introduces the Sun-3 generation, priced at $12,900 for the Sun 3/75 desktop workstation; $20,900 for 3/160

November 1984 — Introduces Network File System, software that allows networks of multi-vendor machines to share files and data

October 1984 — Kodak agrees to purchase $20 million of common stock

November 1983 — Introduces the Sun-2 generation, priced at $16,900

Sources: ELECTRONIC BUSINESS, Sun Microsystems Inc.

Hampton, N.H., a market research firm. As McNealy describes it, "I try to make as few decisions as possible."

For McNealy, institutionalizing growth meant crafting a fluid organization: buying and not leasing facilities; contracting out much of the manufacturing; raising capital not when the need was pressing but when the market was right. It meant luring executives who already knew how to run billion dollar companies to Sun, then only a $9 million to $40 million firm. "Scott didn't have enough experience to know you couldn't do things. And so he hired himself these industry veterans, and then he said, 'here's what we're going to do,' " explains Beveridge.

There's no question Sun's constant start-up pace has come at a price: higher attrition. Over three years, annual labor turnover crept from 9% to more than 11.5% now. Stress has taken its toll, and workers increasingly complain a company can't run the way Sun runs. When Sun was young, McNealy dealt with such symptoms by gathering everyone together for a pep talk. But last April, Beveridge says Sun "collected thoughts on the state of morale." It responded with a Quality of Life plan designed to get people back in touch with Sun's mission and strategy. The goal? To revive the place's old start-up feel.

It seems an unusual move for Sun to embrace the stability of the past. Its organization has always been fluid, flexible, dismantled one day and reassembled the next. "We get a lot of rap about our organization. I couldn't draw you an org chart if I tried. . . . We must reorganize something every quarter," says Zander. Sun executives are fond of repeating McNealy's stable of business axioms. Zander's offering: "Never let the organization get in the way of opportunity."

That spelled autonomy — a philosophy that paid off for Sun. "The problem with all that growth is it requires a kind of flexibility to roll with the events as they come and seek out opportunities a more rigid organization wouldn't have pursued," says Mark Stahlman, an analyst with Sanford C. Bernstein & Co. Sun, for example, introduced its family of 386*i* workstations in April 1988 only after rounds of internal debate among divisions. "If it hadn't been for fairly decentralized power [Sun] would probably have missed the most successful product launch in Sun's history."

McNealy's penchant for organizational change has let him willingly trade upheaval for innovation. Early in 1985, when Sun was a 900-employee company with sales approaching $115 million, McNealy held a series of meetings on launching the company into additional markets. When McNealy felt his managers were letting too many projects fall to the bottom of their lists, he revamped their priorities. McNealy announced the creation of four autonomous divisions corresponding to four new markets: low-end products; software; the federal government; and customer service as a profit center.

Deploying able bodies

Sun's informal hierarchy offered another advantage — the flexibility to meet tighter operating costs during the summer of 1985, a recessional period for the industry. Throughout the summer months, Sun raced to meet the Sept. 9 product introduction date for its family of Sun-3 computers. But during that quarter Sun clamped down on hiring, and met the introduction date only by shifting people to the important product launch. "We took all able bodies," recalls Carol Bartz, recently named vice president of the customer service division and a longtime Sun veteran. "A rigid hierarchy wouldn't have been able to do it."

Maybe so. But Sun's loose, freewheeling style is in many ways a two-edged sword. For managers, it made Sun's fast-growth pace livable. Take John Hime, a former Sun marketing manager: "I always had the feel they let me run my own little business. You can deal with the stress when the control is yours." But while autonomy let Sun managers make decisions quickly, autonomy itself was stressful. Sun's fast growth forced its managers to shoulder far more responsibility and decision-making than their counterparts at slow-growth companies.

Autonomy, for example, nearly destroyed the sets of checks and balances most companies live by. "The planning function at Sun three years ago was laughable. It was amazing a $500 million company was flying blind," says Austin Wing Mayer, director of investor relations. When Mayer joined in 1987, he recalls "there was no accountability for profits and loss; no sense of responsibility in terms of any hiring plan."

At the time Mayer came on board, he says Sun typically made financial forecasts just six months ahead. Only now, with signs such as the recent hiring of Sun's first director of corporate planning and strategy, is the discipline of casting five-year plans

Adolescent Sun: How wild-and-crazy worked in the past

- Participatory management allowed quick decision making
- Autonomy for individual managers permitted the opportunistic April 1988 launch of Sun's successful 386*i* workstation
- Flexible staffing structure: By putting all able bodies on the Sun-3 project, Sun met the September 1985 launch deadline
- Leasing buildings enhanced flexibility
- McNealy's pep talks at beer blasts kept the mission clear

Grown-up Sun: A dose of discipline

- Since mid-1987, tight financial controls have been implemented. Five-year macro forecasts have replaced six-month outlooks
- Three-inch thick "Financial Policy Manual" helps limit Sun's exposure to bad deals
- Manager's compensation became linked to performance in 1987
- The hiring process has been automated. An AI-based computer system analyzes and distributes resumes
- Sun's now buying and building facilities in the United States and overseas
- A formal Quality of Life plan has been designed to revive a sense of mission

catching on. "Since I've been here, we've actually looked out to the early 1990s in terms of macro revenue, employee business models and marketing," adds Zander.

Sun's era of tighter financial controls began when Joseph Graziano, Apple's former financial officer, took the reins from the retiring Bob Smith in May 1987. Sun instituted some tough cash flow objectives, like slashing the days of outstanding receivables from 55 down to 48 in a year's time. In 1987, Sun announced a policy change that stunned homegrown managers accustomed to freewheeling autonomy: Compensation was suddenly performance-linked. Managers who only delivered on seven of the 10 objectives on their lists, for example, would be eligible for 70% of their bonuses. Mayer calls the reaction "pretty rocky going."

"I can remember sitting in on some operating committee meetings," he says, "where the managers were very resentful of someone looking over their shoulder and dictating to them how much they had, and they had to account for that money. The managers really fought back."

It's confounding why Sun didn't simply jettison the managers. According to Mayer, there were several cases where "managers would go out and find a multi-million dollar deal and it never got elevated to the proper levels of the company. It never got reviewed by legal counsel ... [they] didn't realize we didn't have the cash on our balance sheet to finance it."

Dangerous autonomy

Few companies would tolerate such dangerous autonomy; Sun apparently agrees. Although Mayer says the deals — which he declined to identify — turned out well, he points to a Financial Policy Manual, some 3 inches thick, dated September 1988. "We are trying to limit the company's exposure to bad deals."

Indeed, there are signs of a changing Sun. Lightning decision-making was once its pride, but now Sun is slowing down. Says McNealy: "We shouldn't respond to situations as quickly as in the past." There's no doubt that Sun's approach to managing growth is changing, as McNealy explains. "As we've gotten bigger, we say 'no' to a lot more things."

For the first time, Sun is also leaping to fix another consequence of fast growth: its slapdash customer support.

McNealy admits customer support "just got away from us." Recently,

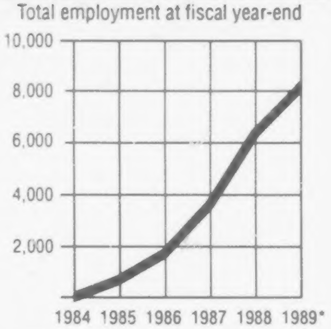
Population explosion: 7,000 new hires in five years

How does a fast-growth company hire and assimilate about 7,000 people in five years? Not easily. Sun Microsystems Inc. dealt with the challenge by introducing a video on recruiting by president Scott McNealy. The purpose, says Crawford Beveridge, vice president for human resources, is to make managers understand "this was an absolutely critical part of what they could do for Sun." Recruiting has been a constant challenge: in five years, Sun grew from 1,200 to 8,900 employees. Beveridge estimates the company receives 300 resumes daily, and reads five for each person interviewed; that's roughly 38,500 resumes in five years.

Initially, Sun spent huge sums on outside recruiters who charged 15% to 20% commissions on each hire's first year salary. Sun resisted an in-house recruiting staff to avoid having excess people on payroll when recruiting slackened. But it never did. "In retrospect, it wasn't the best call in the world," allows Beveridge. Sun wised up in 1985, when it slashed costs by hiring roughly 20 contract recruiters.

One of Sun's most forward-looking moves has been automating recruiting with Resumix, a $60,000 artificial intelligence-driven Unix-based software package. Previously, human resources reproduced some 30 copies of each resume and distributed them to Sun divisions. The AI system, says Beveridge, "would have been absolutely useless to us four years ago. It would have been a lot faster to walk across to the other building." Installed this year, Resumix scans resumes and enters them into the Sun network both verbatim and in a summarized form that highlights, for example, knowledge of programming languages. Managers access the system and key in the type of experience they need, and out pop the appropriate resumes.

Sun's growing people power



Fiscal years ending June 30
* Feb. 1989
Source: Sun Microsystems Inc.

As Sun's population exploded, the company managed growth in two ways. First, assimilating new hires began at the front end by weeding out "un-Sunlike" candidates at the first interview. "Over the years, you know who fits in, and they're not from slow-growth companies," says Carol Bartz, a vice president who has been with Sun for more than five years. "I do a sanity/culture check. 'Do you know what a wild and crazy and hard-working place Sun is?' You know when to dig more on the question."

As well, Sun routinely hired people overqualified for the job they were hired to perform. That kind of strategic hiring keeps people's abilities in step with Sun's fast growth, but the screening process can consume as much as one-quarter of a manager's time.

In late 1985, Sun began its first formal employee orientation; it is still taught by McNealy, assisted by vice presidents. Sun took its first steps into management training and career development in 1986. The pattern is clear: Sun is beginning to take on the trappings of a more mature company. ☐

the problem exploded. Callers to Sun's toll-free number wouldn't hear back from the company for days at a time. Complaints about the lack of immediate attention escalated: Sun responded by training and nearly doubling the number of people handling calls. "We aren't perfect about anticipating problems. This one got out of hand," says Bartz.

Historically, spending on customer support took a backseat to R&D expenses. Only now is the ratio changing. Sun's reined in hiring sales representatives. Now, about 10% of new hires are in customer service, compared with 20% in sales and marketing. That reallocation of resources, says Bartz, is typical of Sun's approach to managing growth.

Adding more support workers, though, will add to another tricky problem for Sun: assimilating outsiders. Communicating Sun's vision was easy back when it was a 300-employee company. Then, McNealy stood on a chair at Sun's routine beer blasts and delivered rousing reminders of Sun's mission. But Sun's phenomenal growth has robbed McNealy of that ease of communication. One of his trickiest problems has been preserving Sun's culture. Instead of speaking from a chair, McNealy now communicates to a camera lens in quarterly videos on strategic issues, problems and solutions.

Senior managers who didn't understand McNealy's vision of Sun are gone. First was Owen Brown, who resigned in 1984, about a year after being recruited from DEC as Sun's president. "You've got to understand the culture of a company. The leader has got to understand it," says board member Marquardt. Yet remarkably few senior managers from Sun's fledgling days have left.

"In seven years, with all the money that's been made here — just check out the parking lot with those cars — all those guys like [VP for sales] Joe Roebuck, the original sales team are all in place," notes marketing vice president Zander. (Sun's merit stock plan covers 1,000 employees; almost 80% of eligible employees participate in its stock purchase plan).

They've stayed, perhaps, because there's plenty of things that Sun has managed well. Among them —manufacturing, where forecasting was made easier by fairly steady increases in demand. Yet as Sun moves into product diversification, the balancing act is getting tougher. Now, there's pressure on Sun to stockpile inventory for both old and new products. Inventory, $15.7 million last September, had ballooned to $23.4 million at year-end. About three years ago, Sun started just-in-time manufacturing and slashed its vendors from a couple of hundred to its current stable of under 100.

Sun manufactures its products in Milpitas, Calif., (450,000 square feet) and in Westport, Mass., (180,000 square feet). From the beginning, Sun built flexibility into its manufacturing by resisting vertical integration. "We spent a large amount of time understanding what our backlog would look like," says James Bean, V.P. of manufacturing. Sun contracts out circuit board stuffing, and purchases some completed assemblies.

That flexibility extends into facilities planning. Favoring the flexibility of leasing in light of its growth, Sun didn't purchase its first building until mid 1988. Last year, it broke ground on its first offshore manufacturing plant in Scotland. Within the next six months, Sun will also evaluate whether it will produce in Japan.

Sun hasn't abandoned the flexibility that allowed it to successfully manage growth to the $2 billion mark. But more than ever, Sun is embracing discipline as a more mature company might. Sun's old cockiness? It may be obsolete. "Discipline," says McNealy, "is not a stuffy word." ☐

Feeding Sun's cash-hungry appetite

Sun Microsystems Inc., with an annual compound growth rate of 161%, has a voracious appetite for cash. Yet because of savvy financing and strategically timed stock and bond offerings, Sun always has had enough cash in the coffers. "Cash has not been a major problem, so obviously they've done it well," says Robert Long, a vice president of Eastman Kodak Co. and a Sun director since April 1988.

Sun has been very careful not to tie up too much capital in fixed assets. In manufacturing, Sun contracts out much of its assembly work. Fluidity is built into its facilities planning as well. Sun leased buildings for years until taking the plunge into ownership in 1988.

"Sun thinks ahead about cash needs and comes up with unique ways of meeting them," adds Long. Among them: In October 1984, about 18 months after Sun went public raising $45 million, Kodak, a major customer, purchased $20 million of Sun common stock. But Sun's deal with AT&T was even sexier.

In fiscal 1988, rapid expansion made Sun devour $12 million in cash monthly. To guarantee long-term working capital, Sun struck a deal with AT&T: over three years, the OEM would purchase newly issued common stock of up to 15% of Sun's outstanding shares. Best yet, Sun would sell the shares at a 25% premium over market value. AT&T also had the option to purchase another 5% of Sun's stock in the open market.

It was a plum arrangement for Sun. AT&T's premium-priced stock was a very creative strategy negotiated by Sun president Scott McNealy and financial officer Joseph Graziano. John Rohal, an analyst with Alex. Brown & Sons Inc., calls the financing "a spectacular deal for them." AT&T is an internal consumer of compilers, an OEM and "a friendly holder of stock." More importantly, adds Rohal, "Sun has a guaranteed availability of stock through 1991."

In fiscal '88, growth made Sun eat $12 million monthly

But not all is bliss. AT&T agreed to the deal at the start of the war over Unix, when alliances over AT&T's version of the operating system were critical. Now, although financially committed to Sun, AT&T appears to be distancing itself from Sun's technology, particularly its Sparc microprocessor. ☐

Facts behind the figures

The following pages comprise ELECTRONIC BUSINESS' special report on fast-growing U.S. electronics companies. The 100 companies listed are all publicly held and are ranked in order of their compounded annual growth rates, calculated over a five-year time span on six years of reported revenue results.

Additional analysis examines the growth rates of particular industry segments, with comparisons with the previous year. ELECTRONIC BUSINESS breaks out the U.S. states with the largest number of fast-growth firms; highlights the corporations with sales in the billions of dollars which still manage to achieve impressive sales gains; examines which companies climbed the fastest growth charts, and why; and looks at where IBM has placed over the past few years.

Top 10 fastest growing companies

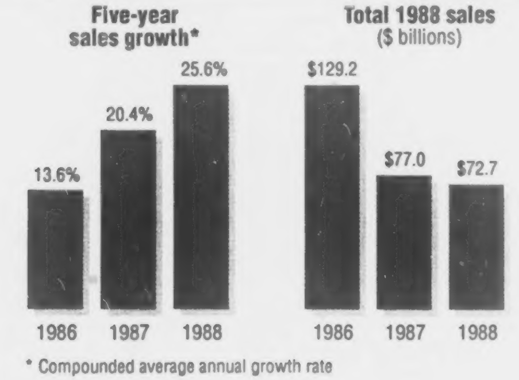
1988 rank	Company	Market	Five-year sales growth	Fiscal 1988 sales ($ millions)
1	**Sun Microsystems**	Workstations	161.2%	$1,051.6
2	**Oracle Systems**	Database software	123.7%	282.1
3	**3Com**	LAN equipment	121.3%	251.9
4	**Novell**	LAN software	118.3%	281.2
5	**AST Research**	Boards and PCs	100.6%	412.7
6	**Symbol Technology**	Bar code scanners	88.0%	89.0
7	**Micron Technology**	Semiconductors	87.0%	300.5
8	**Mark IV Industries**	Diversified	79.6%	403.0
9	**Compaq Computer**	Microcomputers	79.4%	2,065.6
10	**Ashton-Tate**	Database software	76.2%	307.3

Faster growth, smaller companies

In 1988, the top 100 fastest growing U.S. electronics companies had a five-year compounded annual growth rate of 25.6%. That marked an increase over 1987's 20.4% climb — and a result that might appear puzzling given that the industry is maturing. But even though the growth rate accelerated, the total revenue declined from $77.0 billion to $72.7 billion in the same period.

One conclusion? The industry is regenerating healthily, as more small companies made the list.

The overall picture



* Compounded average annual growth rate

New entries to the fastest growing list

Company	Five-year sales growth	Fiscal 1988 sales ($ millions)	1988 rank
3Com	121.3%	$251.9	3
Novell	118.3%	281.2	4
Symbol Technologies	88.0%	89.0	6
Compaq Computer	79.4%	2,065.6	9
Computer Associates	64.9%	709.1	17
Rexon	63.6%	155.5	19
Hutchinson Technology	47.8%	113.7	30
Valid Logic Systems	46.5%	108.4	32
Xicor	41.8%	90.1	36
KLA Instruments	37.0%	112.9	39

New guys in town

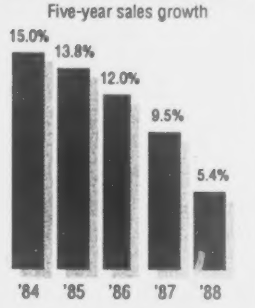
New to the list are 26 firms, with at least one surprise among them. 3Com and Novell head the top 10 newcomers, and their position owes more to the market they drive — small computer connectivity — than to their own youth. Software behemoth Computer Associates is getting big by buying company after company. And KLA Instruments is, on the face of it, the surprise: a fast-growing IC production equipment maker?

KLA is most active in optical inspection techniques. Its ranking is an indication that quality is uppermost in the minds of managers these days.

Where's IBM?

Big Blue once made the fastest growing list: in the heydey of the PC, it showed up with 15% average annual growth. Not anymore. IBM last year produced a 5.4% sales gain — evidence that it has lost steam in PC markets and that mainframe and minicomputer sales have yet to regain momentum.

IBM's slide



Billion dollar companies keep on ticking

Company	Fiscal 1988 sales ($ millions)	Five-year sales growth	1988 rank
DEC	$11,475.4	21.9%	69
Unisys	9,902.0	18.2%	82
Hewlett-Packard	9,831.0	15.9%	100
Apple Computer	4,071.4	32.9%	44
Intel	2,874.8	20.7%	74
Compaq Computer	2,065.6	79.4%	9
Amdahl	1,801.8	18.3%	81
Prime Computer	1,594.6	25.3%	61
Loral	1,440.8	36.0%	40
Tandem Computers	1,314.7	25.7%	59
Seagate Technology	1,266.0	62.9%	21
Advanced Micro Devices	1,125.9	25.7%	60
Sun Microsystems	1,051.6	161.2%	1

The billionaires are still bountiful

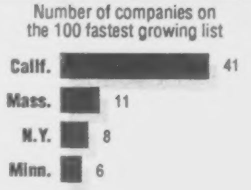
You'd think that giant corporations with sales in the billions of dollars would be pushed to grow much at all. But 13 of the billion-dollar-plus club made the lists. Several others didn't cut it, among them: Amp (12%); E-Systems (13%); Motorola (13%); Tandy (11%); Wang (15%); and Zenith (15%). The figures are for five-year compounded growth.

California gold rush; Mass. misery

The Golden State holds its previous year's lead as the state with the most revenue racers. Last year, 41 of the fastest called California home — the same as in 1987. New England reflects the erosion of the "Massachusetts Miracle:" the Route 128 score is 11, down from 14 a year earlier.

Of the 26 newcomers to the lists, California claims seven, but New York (5), Minnesota (3) and Texas (2) are inching up.

Hot growth spots



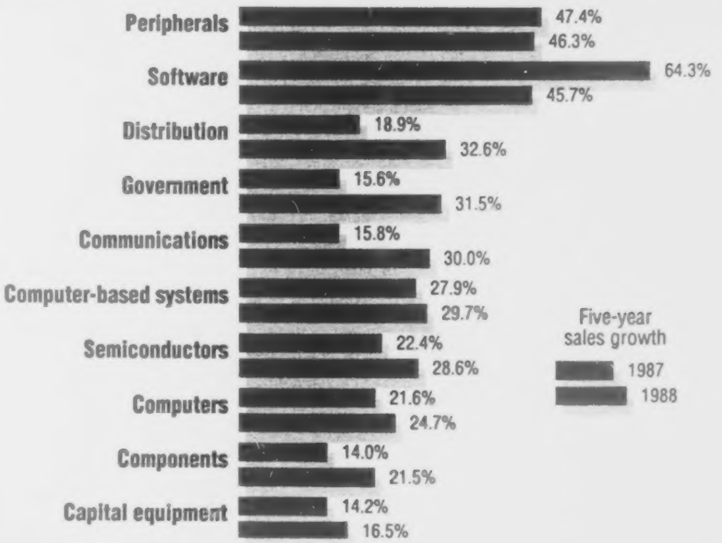
Peripherals makers head hot-growth pack

Makers of computer peripherals products scored the highest collective average growth rate — 46.3%, followed by the previous year's top-ranked sector, software firms, with 45.7% compounded annually.

Software sector growth has backed off some: in 1987, it showed 64.3%, which means that the business is maturing and consolidating. But, software shows more companies: nine in this year's lists, compared with six in 1987. Oracle Corp., developer and marketer of relational database management systems, led the pack of software companies with a five-year compouded average annual growth rate of 123.7%, making it one of the fastest growing software companies.

Comparing the weighted averages for 1987's versus 1988's five-year compouned average annual growth, all segments showed an improvement except for software.

Peripherals companies the fastest growing segment



1988's fastest growing U.S. companies

1988 rank	Company	Five-year sales growth*	Fiscal 1988 sales ($ millions)	Fiscal 1988 profits ($ millions)	Fiscal year ended	Location
1	**Sun Microsystems**	161.2%	$1,051.6	$66.4	6/88	Mountain View, Calif.
2	**Oracle Systems**	123.7%	282.1	42.9	5/88	Belmont, Calif.
3	**3Com**	121.3%	251.9	22.5	5/88	Santa Clara, Calif.
4	**Novell**	118.3%	281.2	30.4	10/88	Provo, Utah
5	**AST Research**	100.6%	412.7	15.1	6/88	Irvine, Calif.
6	**Symbol Technologies**	88.0%	89.0	20.2	6/88	Bohemia, N.Y.
7	**Micron Technology**	87.0%	300.5	98.0	8/88	Boise, Idaho
8	**Mark IV Industries**	79.6%	403.0	17.0	2/88	West Amherst, N.Y.
9	**Compaq Computer**	79.4%	2,065.6	255.2	12/88	Houston, Texas
10	**Ashton-Tate**	76.2%	307.3	47.8	1/88	Torrance, Calif.
11	**Iomega**	73.6%	111.5	8.6	12/88	Roy, Utah
12	**Wyse Technology**	73.3%	456.6	28.0	3/88	San Jose, Calif.
13	**Western Digital**	72.6%	768.3	43.0	6/88	Irvine, Calif.
14	**Stratus Computer**	66.8%	265.3	29.3	12/88	Marlboro, Mass.
15	**QMS**	66.5%	186.7	-5.0	9/88	Mobile, Ala.
16	**Intelligent Systems**	65.1%	152.6	-9.0	12/88	Norcross, Ga.
17	**Computer Associates**	64.9%	709.1	101.8	3/88	Garden City, N.Y.
18	**Microsoft**	63.8%	590.8	123.9	6/88	Redmond, Wash.
19	**Rexon**	63.6%	155.5	9.0	9/88	Culver City, Calif.
20	**Mentor Graphics**	63.4%	300.8	33.5	12/88	Beaverton, Ore.
21	**Seagate Technology**	62.9%	1,266.0	77.3	6/88	Scotts Valley, Calif.
22	**LSI Logic**	61.2%	378.9	23.8	12/88	Milpitas, Calif.
23	**Digital Communications Assoc.**	59.9%	227.5	42.2	6/88	Alpharetta, Ga.
24	**Lotus Development**	54.6%	468.5	58.9	12/88	Cambridge, Mass.
25	**Apollo Computer**	52.0%	653.5	0.2	12/88	Chelmsford, Mass.
26	**Archive**	51.7%	122.7	10.5	9/88	Costa Mesa, Calif.
27	**MiniScribe**	51.1%	603.3	25.9	12/88	Longmont, Colo.
28	**Symbolics**	50.8%	81.3	-46.0	6/88	Cambridge, Mass.
29	**Emerson Radio**	50.3%	728.8	-12.0	3/88	North Bergen, N.J.
30	**Hutchinson Technology**	47.8%	113.7	4.3	9/88	Hutchinson, Minn.
31	**Micropolis**	46.9%	353.1	-19.4	12/88	Chatsworth, Calif.
32	**Valid Logic Systems**	46.5%	108.4	6.1	12/88	San Jose, Calif.
33	**Daisy Systems**	46.4%	117.4	6.9	9/88	Mountain View, Calif.
34	**VLSI Technology**	43.9%	221.2	6.7	12/88	San Jose, Calif.
35	**Anthem Electronics**	43.7%	264.6	11.3	12/88	San Jose, Calif.
36	**Xicor**	41.8%	90.1	14.0	12/88	Milpitas, Calif.
37	**Silicon Systems**	39.8%	120.8	12.7	9/88	Tustin, Calif.
38	**Ultimate**	39.8%	209.2	13.0	4/88	East Hanover, N.J.
39	**KLA Instruments**	37.0%	112.9	8.8	6/88	Santa Clara, Calif.
40	**Loral**	36.0%	1,440.8	74.3	3/88	New York, N.Y.
41	**Quantum**	35.2%	188.5	-3.2	3/88	Milpitas, Calif.
42	**Cray Research**	34.8%	756.3	156.6	12/88	Minneapolis, Minn.
43	**SCI Systems**	33.5%	774.2	19.0	6/88	Huntsville, Ala.
44	**Apple Computer**	32.9%	4,071.4	400.3	9/88	Cupertino, Calif.
45	**Intermec**	31.9%	85.2	5.2	3/88	Lynnwood, Wash.
46	**Telxon**	30.6%	123.9	14.0	3/88	Akron, Ohio
47	**BancTec**	30.5%	93.4	6.4	3/88	Dallas, Texas
48	**Emulex**	29.5%	125.1	9.1	6/88	Costa Mesa, Calif.
49	**Ask Computer**	29.3%	142.4	10.8	6/88	Los Altos, Calif.
50	**Instrument Systems**	29.1%	381.1	6.1	10/88	Jericho, N.Y.

* Compounded average annual growth rate

(Continued)

Electronic Business

1988's fastest growing U.S. companies

1988 rank	Company	Five-year sales growth*	Fiscal 1988 sales ($ millions)	Fiscal 1988 profits ($ millions)	Fiscal year ended	Location
51	**Bolt Beranek and Newman**	29.0%	$305.2	$18.1	6/88	Cambridge, Mass.
52	**LTX**	28.3%	174.8	7.0	7/88	Westwood, Mass.
53	**Richardson Electronics**	28.2%	118.3	11.2	5/88	La Fox, Ill.
54	**Applied Materials**	28.0%	362.8	40.0	10/88	Santa Clara, Calif.
55	**Microsemi**	27.9%	83.7	2.5	9/88	Santa Ana, Calif.
56	**Marshall Industries**	26.4%	420.4	17.6	5/88	El Monte, Calif.
57	**Intergraph**	26.0%	800.2	88.0	12/88	Huntsville, Ala.
58	**Data Switch**	25.8%	113.8	3.3	12/88	Shelton, Conn.
59	**Tandem Computers**	25.7%	1,314.7	94.5	9/88	Cupertino, Calif.
60	**Advanced Micro Devices**	25.7%	1,125.9	19.3	12/88	Sunnyvale, Calif.
61	**Prime Computer**	25.3%	1,594.6	19.0	12/88	Natick, Mass.
62	**Applied Magnetics**	23.6%	293.0	23.7	9/88	Goleta, Calif.
63	**Molex**	23.3%	502.4	59.3	6/88	Lisle, Ill.
64	**Diceon Electronics**	23.1%	140.7	9.9	9/88	Irvine, Calif.
65	**Network Systems**	22.8%	131.5	11.4	12/88	Minneapolis, Minn.
66	**Systematics**	22.8%	179.5	15.4	8/88	Little Rock, Ark.
67	**Dynatech**	22.3%	367.8	24.5	3/88	Burlington, Mass.
68	**American Management Systems**	21.9%	213.3	7.4	12/88	Arlington, Va.
69	**DEC**	21.9%	11,475.4	1,305.6	6/88	Maynard, Mass.
70	**Burr-Brown**	21.8%	176.7	11.5	12/88	Tucson, Ariz.
71	**Vishay Intertechnology**	20.9%	109.0	15.5	6/88	Malvern, Pa.
72	**Micom Systems**	20.8%	223.4	9.8	3/88	Simi Valley, Calif.
73	**Cullinet Software**	20.7%	216.7	-47.0	4/88	Westwood, Mass.
74	**Intel**	20.7%	2,874.8	452.9	12/88	Santa Clara, Calif.
75	**AVX**	20.5%	408.9	27.6	12/88	Great Neck, N.Y.
76	**Norstan**	20.1%	85.9	2.4	4/88	Plymouth, Minn.
77	**Dynamics Research**	19.1%	92.9	4.1	12/88	Wilmington, Mass.
78	**Finnigan**	18.8%	130.7	8.2	12/88	San Jose, Calif.
79	**Altos**	18.7%	175.9	22.2	6/88	San Jose, Calif.
80	**ADC Telecommunications**	18.7%	179.9	17.0	10/88	Bloomington, Minn.
81	**Amdahl**	18.3%	1,801.8	213.8	12/88	Sunnyvale, Calif.
82	**Unisys**	18.2%	9,902.0	680.6	12/88	Detroit, Mich.
83	**General DataComm**	18.1%	196.2	-18.4	9/88	Middlebury, Conn.
84	**Sheldahl**	17.8%	83.9	0.5	7/88	Northfield, Minn.
85	**Cipher Data Products**	17.7%	185.4	10.4	6/88	San Diego, Calif.
86	**Gerber Scientific**	17.7%	264.0	29.6	4/88	South Windsor, Conn.
87	**Park Electrochemical**	17.6%	128.1	7.0	2/88	Lake Success, N.Y.
88	**Diasonics**	17.6%	281.6	9.8	12/88	South San Francisco, Calif.
89	**Priam**	17.5%	142.0	0.5	6/88	San Jose, Calif.
90	**Recognition Equipment**	17.4%	260.8	-12.2	10/88	Dallas, Texas
91	**AEL Industries**	17.3%	119.6	2.1	2/88	Landsdale, Pa.
92	**Cherry**	17.3%	194.6	7.4	2/88	Waukegan, Ill.
93	**Zeus Components**	17.3%	98.5	0.9	9/88	Port Chester, N.Y.
94	**Measurex**	16.7%	265.2	37.1	11/88	Cupertino, Calif.
95	**Pioneer-Standard**	16.5%	254.6	5.2	3/88	Cleveland, Ohio
96	**ISC Systems**	16.5%	170.8	8.2	6/88	Spokane, Wash.
97	**Evans & Sutherland**	16.4%	129.6	1.9	12/88	Salt Lake City, Utah
98	**Management Science America**	16.3%	250.0	-33.6	12/88	Atlanta, Ga.
99	**Logicon**	16.2%	218.9	9.1	3/88	Torrance, Calif.
100	**Hewlett-Packard**	15.9%	9,831.0	816.0	10/88	Palo Alto, Calif.

* Compounded average annual growth rate

Source: ELECTRONIC BUSINESS

1988's fastest growing U.S. companies by industry segment

Capital equipment

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
KLA Instruments	37.0%	24.7%	39
LTX	28.3%	22.8%	52
Applied Materials	28.0%	67.3%	54
Vishay	20.9%	28.5%	71
Gerber Scientific	17.7%	45.8%	86
Hewlett-Packard	15.9%	13.6%	100
Weighted average	**16.5%**	**15.3%**	

Communications

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
3Com	121.3%	331.9%	3
Novell	118.3%	NM	4
Digital Communications Associates	59.9%	82.9%	23
Instrument Systems	29.1%	20.6%	50
Bolt Beranek and Newman	29.0%	40.7%	51
Data Switch	25.8%	-11.6%	58
Network Systems	22.8%	2.5%	65
Dynatech	22.3%	20.2%	67
Micom Systems	20.8%	-4.6%	72
Norstan	20.1%	24.8%	76
Dynamics Research	19.1%	32.0%	77
ADC Telecom	18.7%	25.4%	80
General DataComm	18.1%	NM	83
Weighted average	**30.0%**	**25.6%**	

Components
(other than semiconductors)

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Microsemi	27.9%	17.4%	55
Molex	23.3%	21.9%	63
AVX	20.5%	26.0%	75
Cherry	17.3%	18.5%	92
Weighted average	**21.5%**	**22.6%**	

Computer-based systems

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Symbol Technologies	88.0%	NM	6
Mark IV Industries	79.6%	78.6%	8
Mentor Graphics	63.4%	NM	20
Valid Logic Systems	46.5%	47.8%	32
Daisy Systems	46.4%	24.4%	33
Telxon	30.6%	NA	46
BancTec	30.5%	NM	47
Ask Computer	29.3%	22.6%	49
AMS	21.9%	29.7%	68
Finnigan	18.8%	NA	78
Recognition Equipment	17.4%	NM	90
Measurex	16.7%	50.5%	94
ISC Systems	16.5%	15.6%	96
Evans & Sutherland	16.4%	-29.5%	97
Weighted average	**29.7%**	**41.3%**	

Computers

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Sun Microsystems	161.2%	152.0%	1
Compaq Computer	79.4%	150.3%	9
Stratus Computer	66.8%	68.0%	14
Rexon	63.6%	NM	19
Apollo Computer	52.0%	-55.5%	25
Symbolics	50.8%	NM	28
Cray Research	34.8%	43.1%	42
Apple Computer	32.9%	44.2%	44
Intergraph	26.0%	24.6%	57
Tandem Computers	25.7%	25.1%	59
Prime Computer	25.3%	-10.2%	61
DEC	21.9%	35.7%	69
Altos Computer	18.7%	22.9%	79
Amdahl	18.3%	37.7%	81
Unisys	18.2%	28.2%	82
Weighted average	**24.7%**	**35.3%**	

Distribution

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Emerson Radio	50.3%	NM	29
Anthem Electronics	43.7%	52.7%	35
Marshall Industries	26.4%	66.7%	56
Zeus Components	17.3%	19.7%	93
Pioneer-Standard	16.5%	53.7%	95
Weighted average	**32.6%**	**27.6%**	

Government

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Loral	36.0%	22.9%	40
SCI Systems	33.5%	23.6%	43
AEL Industries	17.3%	-1.0%	91
Logicon	16.2%	15.6%	99
Weighted average	**31.5%**	**21.3%**	

Peripherals

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
AST Research	100.6%	56.5%	5
Iomega	73.6%	NM	11
Wyse Technology	73.3%	90.1%	12
QMS	66.5%	NM	15
Intelligent Systems	65.1%	NM	16
Seagate Technology	62.9%	43.9%	21
Archive	51.7%	67.6%	26
MiniScribe	51.1%	55.8%	27
Micropolis	46.9%	NM	31
Quantum	35.2%	NM	41
Intermec	31.9%	19.4%	45
Emulex	29.5%	10.3%	48
Applied Magnetics	23.6%	28.7%	62
Sheldahl	17.8%	NM	84
Cipher Data Products	17.7%	11.8%	85
Priam	17.5%	-30.0%	89
Weighted average	**46.3%**	**29.5%**	

Semiconductors

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Micron Technology	87.0%	NM	7
Western Digital	72.6%	96.3%	13
LSI Logic	61.2%	19.1%	22
VLSI Technology	43.9%	NM	34
Xicor	41.8%	NM	36
Silicon Systems	39.8%	NM	37
Richardson Electronics	28.2%	34.8%	53
Advanced Micro Devices	25.7%	-1.6%	60
Burr-Brown	21.8%	21.8%	70
Intel	20.7%	31.3%	74
Weighted average	**28.6%**	**38.5%**	

Software

	Five-year growth* Sales	Five-year growth* Profits	1988 rank
Oracle Systems	123.7%	130.6%	2
Ashton-Tate	76.2%	113.7%	10
Computer Associates	64.9%	79.4%	17
Microsoft	63.8%	80.4%	18
Lotus Development	54.6%	33.8%	24
Ultimate	39.8%	23.0%	38
Systematics	22.8%	26.9%	66
Cullinet Software	20.7%	NM	73
Management Science America	16.3%	NM	98
Weighted average	**45.7%**	**41.1%**	

NA = Not available

NM = Not meaningful, company had a loss in one of the base years

* Compounded average annual growth rate

Source: ELECTRONIC BUSINESS

Growth master Conner ramps for doubling of shipments

The mini-drive maker has already broken first-year sales records. Tight ins with vendors may help win more glory

In talking fast growth, it would be remiss not to mention one of the hottest growth companies ever — Conner Peripherals Inc.

Riding the coattails of its largest customer, Compaq Computer Corp., the San Jose-based rigid disk drive maker scored record first-year sales of $113 million, breaking Compaq's own 1983 record of $111 million — at the time considered to be the fastest first-year performance in U.S. business history.

The newcomer also enjoyed Compaq's early endorsement in the form of a $12 million equity investment. And Conner's growing customer list reads like a *Who's Who* in laptop computing, including Toshiba America Inc., Zenith Data Systems Corp. and Grid Systems Corp.

(Conner Peripherals, just 3 years old, is excluded from the ELECTRONIC BUSINESS fast-growth survey because the listing qualifies companies according to a five-year compounded annual growth rate.)

Specializing in making and selling 3.5-inch drives for OEMs, Conner finished 1988 with brisk sales of $257 million, a whopping 127% increase from 1987. Net profits jumped too, to $20 million, up 74%. In its second year of business, the company went public. But such growth is even more incredible considering that Conner began 1988 with a 25% downturn in first-quarter sales, resulting in about 100 layoffs. It was, at best, a turbulent year for the entire disk drive industry.

However, such hard times, say industry watchers, awakened the industry to increased customer demand for 3.5-inch drives and generally forced the industry to pick up its pace — something the flamboyant, 45-year-old Finis Conner, founder, chairman and CEO of Conner Peripherals, welcomes. "I like the market extremely fast," he says. "While my competitor is trying to figure where to go next, I'm running away from him." Conner boasts development cycles that are shorter than ever: some six months from concept to full production.

Conner, a 17-year industry veteran and cofounder of drive titan Seagate Technology, saw the market coming: his 1986 business plan proposed first-year sales of $110 million, $3 million under actual sales. Quality was a given throughout, despite the demands of fast growth: "In this business, you do not have the luxury of introducing a product and then hoping over time to improve it," says Conner. But managing the firm's climb, he admits, was no easy task.

Conner met part of the growth challenge by parceling out plenty of component and subassembly work. Steering around capital and labor-intensive manufacturing, the company has built strong long-term relationships with customers and suppliers, key to the Conner strategy. Instead of building its own, Conner buys fully assembled and tested components such as recording-head stacks. "Our vendors get a higher value-added than they do with other people," says Conner. "We believe the cost is less than doing it ourselves."

Fast moves from Finis: Tight deals with vendors, buyers helped give CEO Finis Conner $113 million in first-year sales

Cindy Charles

Closer with customers

Strategy No. 2 is working closely enough with customers, designing drives early on in the system's design cycle, to gain advantage by gauging the ups and downs of product demand. This gives a good idea of production needs up to a year in advance, taking much of the risk out of over- or under-producing.

A third strategy has been to gear the whole organization for growth, which calls for breaking out new product responsibilities. Former president William Schroeder was recently appointed vice chairman and president of a new products group — this as part of a formal restructuring that took place early this year. The new company president and COO is William J. Almon, an IBM alumnus.

Conner faced plenty of early challenges: being inundated with orders, making a last minute design change and then discovering a key supplier to be unable to ramp-up its production to fill those orders to the new specifications.

Conner's solution was to hire additional staff who could make the components work in the current design. Although not a cost-efficient solution, says Conner, the company managed to keep up with the demand.

Another problem encountered in the fast lane to success was having inadequate staffing to screen incoming vendor products for quality. During 1988, the company hired more than 1,300 employees, sometimes hiring as many as 100 a week. And even though Conner Peripherals now prides itself on having tight working relationships with selected vendors, there was a time when "we had to work with more vendors than we wanted to," says Conner.

And Conner is nowhere near slowing down. Analysts predict the company will double the units it shipped last year to 2 million in 1989. Also, as part of the company's restructuring plan, high-volume manufacturing has been moved from San Jose to a new Singapore plant, which will have a capacity of nearly 3 million units by June.

JOHN McCREADIE

TeleVideo: A lesson in how *not* to grow fast

Revenue from the maker of PCs and terminals is nothing like the old days of '83. Here's how growth went negative

Although summer is just around the corner, business is not exactly blooming for TeleVideo Systems Inc. The former high-flying maker of small computers and terminals is now taking a bath in red ink — a sorry situation for a company that once was acclaimed as a classic "rags to riches" immigrant story.

The Sunnyvale, California-based TeleVideo was started in 1975 by Philip Hwang, who just 11 years earlier had arrived from Korea with $50 in his pocket.

Hwang's display terminals business went well in the wake of the minicomputer revolution; in fact, TeleVideo was heralded as one of the fastest growing companies of the early 1980s. The company also began moving into the small computer systems market, and the talk was of challenging Apple Computer Inc. By 1982, sales had neared $100 million, and for fiscal 1983, ended Oct. 31, revenue hit $168 million with net income of $22.4 million.

It's all been downhill since.

In fiscal 1988, TeleVideo showed losses of over $39 million on sales of just $95 million. That represented a steady revenue slide that averaged a negative 10% annual growth.

What went wrong? What's the lesson in all of this for today's fast-growing electronics companies? There's a clear answer from Dallas Talley, TeleVideo's president and COO since last November: "There was not enough focus," he admits.

Lack of focus

TeleVideo was seduced by the prospect of making bundles in the PC business and lost its lead in the still-vital terminals sector to the more aggressive, more focused rival Wyse Technology. And the firm's lack of focus stemmed partly from what Talley concedes was an attitude of overconfidence. "When you're winning, you have this feeling that you're invincible," he explains.

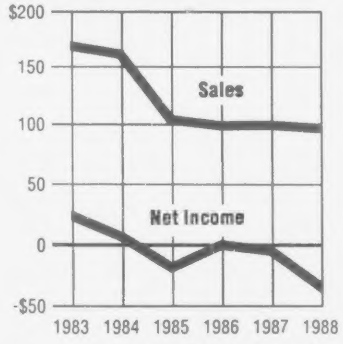
Observers cite plenty of other strategic and tactical errors, including a poorly timed move to manufacturing in South Korea. "Maybe it should have been done in 1982 instead of the following year," laments Talley. The Korean factory has fielded other management distractions: last fall it was hit by a 1-month strike that cut sharply into product availability.

Delivery problems

There have been other difficulties. TeleVideo clearly dropped the ball on delivery, particularly with new models, such as its TelOAS microcomputers and the model 965 multifunction terminal. Greg Blatnik, an analyst with San Jose-based market research firm Dataquest Inc., notes that the company's chief problems stem from late shipping combined with products that are not up to the current level of buyer interest. Getting the product out on time "is always a problem when you're trying to stay on the leading edge," says Talley. A program is now under way to help ease deliveries back on schedule.

That's no way to grow

TeleVideo's financial results for fiscal years ending Oct. 31 ($ millions)



Source: TeleVideo Systems Inc.

The company's most recent financial data cite component shortages (particularly DRAMs) that hurt fiscal 1988's first three quarters, helping scale gross margins back from 1987's average of 26.6% to 9.4% in 1988.

Product demand remains lackluster, as one sales representative of a New England office of major national distributor Arrow Electronics Inc. attests: "There's not too much of a demand from buyers for any of their [TeleVideo's] line. As long as I've been working here, since 1986, I haven't seen one sales rep from TeleVideo walk through our doors."

Additionally, Philip Hwang is "not the easiest person to deal with," according to Eileen O'Brien, a researcher with market research firm International Data Corp. of Framingham, Mass. Such difficulties are given as a likely reason for the high executive turnover of recent years. Hwang, as chairman and founder, still owns over 50% of the company. TeleVideo is well aware of the turnover issue and hopes that Talley's recent appointment as president will be the solution, observers say. "By bringing in new blood, TeleVideo feels it will bring a new perspective, a new thrust to its problems," says O'Brien.

Lack of focus, poor timing, late shipments and inadequate leadership all add up to a former market leader that has been completely eclipsed in seven years. For now, TeleVideo is in the business of regrouping under Talley, with the goal of getting back to the black by the end of October.

The company is trying. In February, it relocated all the firm's U.S. operations, except for its regional sales offices, back to one building in San Jose. The move allows TeleVideo, which has 641 employees worldwide, down from approximately 1,100 in 1983, to consolidate and centralize operations. Among them are manufacturing, sales and marketing, engineering, finance and administrative functions for all local sites as well as for subsidiaries Advanced Transducer Devices and Silicon Logic Inc.

"Moving all of our employees and operations into one facility will be more efficient, and represents another step in the plan to meet our goal of profitability by the end of the fiscal year," Hwang has said. The next step may have to be even bigger than that.

CARRIE MALONE

Thinking points for managers of high-growth companies

A shrinking "knowledge to implementation" gap means managers must know what to do, and then move fast

BY REGIS McKENNA

Regis McKenna is the chairman and CEO of Regis McKenna Inc., a technology marketing consulting firm based in Palo Alto, Calif. He is also a general partner of Kleiner, Perkins, Caufield & Byers, a venture capital firm in Palo Alto.

It took Apple just seven years; Sun, six years; and Compaq, five years to reach $1 billion in revenue. Technology-based companies founded before the 1980s took decades to reach that level of revenue. This time compression creates a "knowledge to implementation" gap. Managers not only have to know what to do, they have to do it quickly. Not only are the businesses young, the industries are young as well. There isn't a lot of seasoned expertise in these new industries, and management practices from one industry don't translate easily into another.

Managing growth cannot be done in the abstract. It has to be done with one foot in the market and one foot in the technology. That way, decisions can be made knowledgeably, gauging the opportunities of the market while assessing the capabilities and resources of the company.

Outlined below are five "thinking points" derived from my observations during 25 years of working with many high-tech, high-growth companies.

Think credibility

Credibility doesn't come from words, it comes from meeting or exceeding the expectations of the market. As sincere as you may want to be, your credibility is derived from the people who constitute the infrastructure of your marketplace. Technology businesses and product success or failure are largely based on word of mouth. Technology business is based on a reference system. It cannot be "promoted" into existence. IBM spent an estimated $100 million advertising the PC*jr*. It failed anyway. Credibility is built upon the references of your customers, your channels and your third-party support, as well as industry analysts and watchers.

High-growth companies always have difficulty keeping reality and perception in balance. If you're successful, the marketplace seems to set expectations for you. It acts as a temptress, drawing you into doing and saying things you feel are required of you. Add to that the uncertainty that prevails over rapid success and equally rapid failure in the high-tech business, and you quickly understand the obsession of most management with creating and holding market positions. There seems to be an incessant push to proselytize the world. Instead of concentrating on building a credible position, management often spends its time striving to meet the demands of perception.

Think capital

From the minute you begin thinking about starting a business, and throughout the life of that business, management is engaged in the process of raising and managing capital. And raising capital requires credibility. In a high-growth business, marketing the company to current and new investors and sources of capital is essential to meeting the expanding demands of adding space, equipment and people. The old maxim "You should raise money when you don't need it" applies particularly to high-growth businesses. The uncertainty of the financial markets, the technology itself, and the ever-changing posture of technology-competitive markets mean that management must keep its fingers on the pulse of the financial markets, seeking opportunities at all times.

High-growth companies are financed, in order of priority, by profits, equity and debt. Profits are crucial to building credibility. Tevye, the lead character in *Fiddler on the Roof*, sings, *"If I were a rich man."* The lyrics go something like this:

"If I were a rich man, I would sit in the temple and lecture to the wise men all day long. And it wouldn't matter if I were right or wrong. When you're rich, they think you really know."

Profits bring you credibility, not only in the eyes of the financial markets, but in the eyes of your current and potential customers as well. Apple Computer Inc., Digital Equipment Corp., Intel Corp. and Sun Microsystems Inc. are all examples of companies whose financial strength has given them a credible platform for building alliances, raising capital and launching new products.

Think and invest ahead of the problem

When fast-growing businesses have to play catch-up, they begin eating into their credibility. As a result, demand and customers quickly outpace the support systems. The first sign is the telephone system. Customers get frustrated trying to reach people (who are always in meetings) and the phrase "they screwed up" begins circulating throughout their marketplace. However, there is an abundance of things that have to be put into place in anticipation of growth: larger facilities, automated manufacturing, computerization, rapidly upgraded inventory and distribution systems, geographic distribution, organizational development, train-

Caroline Alterio

ing, service and many more.

There is no time to learn on the job. You have to act rather than plan. Competition moves quickly to follow up on the next generation of products, creating a sense of urgency. Few companies have experienced the high growth of Adobe Systems Inc., Apple, Ashton-Tate, Convex Computer Corp., Microsoft Corp. or Sun. Early in its history, Apple invested in computerized inventory and distribution systems. The Macintosh factory is well known for its automated systems. Furthermore, the investment took a big gulp, but it paid off as the demand for the Mac took off.

Managing growth has to be done with one foot in the market and one foot in the technology

Convex invested in an international sales, marketing and services organization long before its competition. Having the support systems in place not only leads to almost half of its sales coming from international business, it also became a barrier to competition.

Tandem Computers Inc. invested in company-wide computer and television networks because CEO Jimmy Treybig believes that the most essential part of managing growth is good employee communication.

Think about your presence in the expanding organization

In high-growth companies there is a tendency for the vision to get lost in the deluge of new people and organizational changes. Decisions must be made quickly. In the high-growth days at National Semiconductor Corp., I remember that all the decision managers were within shouting distance of one another. Meetings could be called quickly. Someone was on a plane within hours to see a customer, to get to a distributor or to visit a plant. These tasks were approached with true team spirit.

As Intel Corp. boomed throughout the late 1970s and early 1980s, members of the executive staff were dispersed to take up their offices in key areas of the company. Senior management presence provides a sense of direction throughout the organization. It enhances communications and training through close personal contact. At Intel, a senior executive attended every strategy meeting. With Andy Grove, Bill Davidow, Jack Carsten or even Bob Noyce in these meetings, employees learned how Intel made decisions faster than they could in any "training session."

New people come from diverse backgrounds and different company cultures. If the new culture (where we are headed and the way we do things to get there) is not quickly adopted, the organization slows down to solve its internal battles. To overcome this barrier, senior people must have the drive, the will and the presence to make things happen. Senior people have to be of one mind and heart, and they must make their presence felt throughout the organization.

The founders of most high-growth, high-tech companies are loved, feared, admired, respected and sometimes despised. Steve Jobs fits all these categories. But he drove his vision and high-quality standards into everyone around him. He was relentless. That's what it takes.

Think market infrastructure

Every industry has an infrastructure or an array of formal and informal alliances that make that particular industry tick. In the personal computer industry, the infrastructure consists of customers; the third-party software and hardware vendors; the distributors, dealers, value-added resellers; the industry analysts; the financial community; and the press. Ten percent of the infrastructure influences the other 90%. It's important for management to know who's in that influential 10% and to keep in constant touch with them.

This isn't a promotional game. It is within this infrastructure that industry standards are set and accepted, where new products are recognized and either accepted or rejected, where new ideas emerge, where new niches are formed and where the new competition first appears. By keeping in touch with your industry infrastructure, you keep your finger on the pulse of the market. That close contact enables you to make the rapid changes and adjustments so crucial to the health of your business. ☐

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U.S. firms in Japan finally cash in on the weak dollar

Revenue jumped 32% for big U.S. electronics makers in '88 — better than their Japanese rivals. Pressure to buy American has helped

BY PAULA DOE

The 20 largest U.S.-owned electronics companies in Japan, finally benefiting from the weak dollar, are growing faster and getting higher returns than most of their local Japanese rivals. Those top companies sold $17.3 billion worth of products to the Japanese market in 1988, and produced an additional roughly $2 billion worth of products there for export back to the United States and to other countries.

That $17 billion is still not a very big chunk of the roughly $90 billion Japanese electronics market, but at least it looks a lot better than the U.S. export numbers. Although total U.S. electronics exports to Japan jumped 43% in 1988, they still came to only $6.3 billion, according to the American Electronics Association. Straight subtraction of that export figure from the total sales of U.S.-owned companies in Japan suggests the major U.S. electronics companies are producing somewhere around $13 billion worth of electronics in Japan.

Thanks to the strong Japanese domestic market, favorable exchange rates, and pressure to buy American, the big U.S. companies in Japan saw average revenue growth of 32% in yen in 1988, or, perhaps more meaningfully, median growth of 18%. Improved exchange rates boosted everyone's dollar-denominated results by another 10% or so.

Fastest growth came at Applied Materials Japan, whose revenue in Japan tripled, reaching $135 million, as Japanese semiconductor makers went back to buying of advanced production equipment with a vengeance. As a result, semiconductor makers Intel Corp. and Motorola Inc. saw their Japan sales jump 65% and 54%, respectively, thanks to hot microprocessors and pressure on the

Jean Francois Allaux

Japanese to buy American.

The U.S. computer makers mainly matched or surpassed growth rates of the Japanese market and of their local rivals. Total Japanese output of computers and industrial electronics equipment increased 14% to 15% in 1988, according to the Electronics Industry Association of Japan.

The 20 largest Japanese electronics makers averaged 10% growth for the year ended March 1988, paced by 14% growth at Fujitsu Ltd. and 11% at NEC Corp. DEC Japan and Yokogawa Hewlett-Packard had 25% and 27% growth, respectively, while IBM Japan, Fuji Xerox, and Nippon Unisys matched the Japanese market with 13% to 16% growth.

Other companies that didn't quite reach this year's $130 million cutoff point to make our top 20 ranking also realized impressive growth. Sun Microsystems Inc. says its sales in Japan jumped 115% to some $116 million. Tandem Computers Inc. saw sales increase 68%, to about $67 million.

Slowest growth — a mere 3% to 7% — among the big companies came at those highly dependent on Japanese defense spending, such as Nippon Avionics and Mitsubishi Precision, where the U.S. partner holds a minority share.

Many of the big U.S. companies are also squeezing U.S.-style margins out of the Japanese market, although, naturally, subsidiaries without the full burden of corporate costs such as R&D, or even in some cases manufacturing, should have higher returns. But while net income at the 20 largest Japanese electronics companies averaged 2% to 3% of revenue in the most recent fiscal year, earnings averaged 7% at the large U.S.-owned companies in Japan for which results are available. Applied Materials earned 26% on its Japan sales; Molex Japan, 14%; and YHP and DEC, 9%.

Fuji Xerox made the sharpest improvement in earnings, upping its net income 175%, to 4% of revenue. Yamatake Honeywell saw 106% improvement, also to 4% of revenue.

Despite the good year for the big U.S. companies in Japan, the AEA estimates the U.S. deficit in electronics trade with Japan increased by 2% — from $20.1 billion in 1987 to $20.5 billion last year — as Japanese electronics exports to the U.S. increased 9.4% to $26.8 billion. By comparison, the U.S. reduced its total worldwide electronics trade deficit by 25%, to $9.6 billion. In terms of Japanese sales to the United States, the 18 largest Japanese companies tracked by ELECTRONIC BUSINESS had estimated sales of about $27 billion in the U.S. in 1987, the latest year for which figures are available. Total electronics exports from Japan came to $25 billion that year.

ELECTRONIC BUSINESS estimates major U.S. electronics companies' sales in Japan from company reports and discussions with company officials. For those companies that do not release their Japan results, we rely on Japanese sources, such as news releases published in the Japanese press and compendiums of corporate financials such as Tokyo Keizai's quarterly *Kaisha Shikiho*. Fairly detailed financial information is published in Japan for almost all corporate entities, thanks in part to Japanese government regulations. We don't try to track those companies that sell through agents in Japan and have no separate corporate entities. The market research firm Dataquest Inc. of San Jose supplies its estimates of U.S. semiconductor makers' sales in Japan. ☐

Top U.S. companies in Japan

1988 rank	Company	Sales in Japan ($ millions)	Total sales of Japanese unit ($ millions)	Sales growth (in yen)	Net income/ sales	Earnings growth (in yen)	Fiscal year ended
1	**IBM Japan**	$6,500	$9,200	13%	15%[1]	20%[1]	12/88
2	**Fuji Xerox** (50% owned by Rank Xerox)	2,800	3,519	16%	4%	175%	10/88
3	**Nippon Unisys** (39% owned by Unisys)	2,000[2]	1,485[3]	14%[3]	2%[3]	20%[3]	3/88
4	**Yokogawa HP** (75% owned by Hewlett-Packard)	835	899	27%	9%	70%	10/88
5	**NCR Japan**	710	842	7%	7%	-7%	11/88
6	**Yamatake Honeywell** (50% owned by Honeywell)	607	735	18%	4%	106%	9/88
7	**Texas Instruments**	591	—	32%	—	—	12/88
8	**DEC Japan**	562	562	25%	9%	-2%	6/88
9	**AMP Japan**	410	420	—	—	—	12/88
10	**Nihon Business Computer** (35% owned by IBM Japan)	315	315	18%	-2%	—	3/88
11	**Motorola**	290	—	54%	—	—	12/88
12	**Intel**	285	—	65%	—	—	12/88
13	**Yokogawa Medical Systems** (75% owned by General Electric)	250	350	—	—	—	11/88
14	**Nippon Avionics** (25% owned by Hughes)	232	237	3%	2%	38%	3/88
15	**Molex Japan**	164	188	13%	14%	13%	6/88
16	**Sony Tektronix** (50% owned by Tektronix)	163	175	—	—	—	5/88
17	**Mitsubishi Precision** (40% owned by Singer)	151	151	7%	1%	31%	3/88
18	**National Semiconductor**	135	—	11%	—	—	12/88
19	**Applied Materials Japan**	135	135	188%	26%	—	10/88
20	**Advanced Micro Devices**	134	—	39%	—	—	12/88

All yen figures are converted at the 1988 average rate of ¥130 = $1. Because their years ended at different times, some companies used slightly different exchange rates in their own reporting

[1] Pretax figures

[2] Estimated Unisys revenue in Japan includes that of the units formerly known as Nippon Univac, Oki Univac and Burroughs Japan, now merged into Nippon Unisys

[3] Nippon Unisys results reported for the year ending March 1988 still include only the old Nippon Univac

Sources: ELECTRONIC BUSINESS, Dataquest Inc.

Savvy Brits snap up small U.S. distributors

The British are coming! U.K. distributors such as Electron House are building New World empires by buying regionals

Too late, the British are here. A weak dollar and a buoyant British economy have meant easy pickings for British investors in the United States. Historically, they have outspent all others, including the Japanese and the Germans, in direct U.S. investments. So it should come as no surprise that America's electronics distribution is acquiring a British accent, too.

In March, $160 million Britain-based Electron House Plc paid $11.15 million for Philadelphia-based Almo Electronics Inc., making it the second British company to enter the U.S. electronics distribution industry this decade. The other was the 1981 purchase by Lex Service Plc of Schweber Electronics, and the subsequent acquisition of four other distributors. Lex is the third largest U.S. distributor today with component sales of around $542 million.

Says Almo's president Anthony Cucchi: "The reason for doing this is so Electron House can grow rather dramatically and can take advantage of the trend toward consolidation in the electronics distribution industry." Any new additions could be either folded into Almo or kept separate depending on what is acquired, he says.

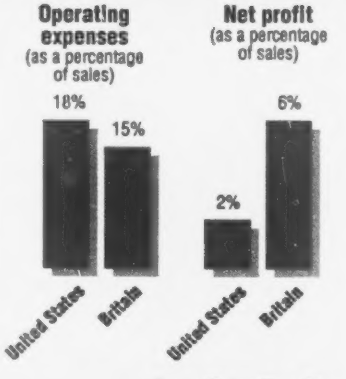
U.S. opportunities

In an industry where long-term profitability is anything but a sure thing, what prompts a foreigner to invest? Quite simply, opportunity. "We believe U.S. distributors are badly run," says Tim Redburn, Electron House's finance director. In general, there is not enough attention to detail, overhead is too high and operating expenses are generally out of hand, he says.

In the British electronics distribution business, operating expenses as a percentage of sales hover around 15% while in the United States, they are around 18%, says Redburn. Similarly, British net profit is usually between 5% and 7%, while in the United States it is closer to 2%. With a leaner organization, there is every reason to expect a U.S. distributor to perform as well as a British one, he adds.

With an eye on the bottom line, Electron House intends on building a $250 million distribution empire in the United States. It will do so by buying up more midsized distributors, putting it in contention for a top 10 position in the industry.

The British want to show U.S. companies how distribution's done...



Source: Electron House Plc

...and are making the buys to prove it

Purchaser	Purchased (Date)
Lex Service	Schweber Electronics (1981)
Electron House	Pacesetter Electronics (1986)
Electron House	Almo Electronics (1989)
Electron House	? (1990)

Source: ELECTRONIC BUSINESS

Besides $45 million Almo, Electron House also owns Pacesetter Electronics Inc., a $10 million West Coast semiconductor distributor that was bought in 1986. It is looking for acquisitions in the $30 million to $70 million range in California, Texas, Florida and the Midwest, says Redburn.

Cultural problems

While Electron House is optimistic about fitting into America, there is always the possibility of cultural problems. Of the three board members of Electron House Inc. — the U.S. subsidiary of the British parent set up to oversee American operations — only Cucchi has any U.S. electronics distribution experience. But he holds a minority share of 10% in Electron House Inc. while Electron House Plc. has 44% and the British venture backers retain 46%.

Problems might develop if Cucchi is vetoed on major strategic decisions. Looking back on the early days of Lex, it had its share of headaches learning the ropes too. Trying to understand Schweber and the way the market worked meant making some mistakes. Schweber was profitable after Lex acquired it and is said to be only modestly profitable now, sources say. There are even rumors that Lex is looking to divest itself of its U.S. electronics distribution operations — rumors the company refutes.

Electron House claims to be up on Lex in two respects: First, Cucchi is a recognized valuable asset. Besides being Almo's president, he is also the president of the National Electronic Distributors Association (NEDA), the industry's trade organization, so he provides much-needed insight, as Redburn says. Second is the fact that Almo is profitable. Even though it could be doing "a couple of points better," says Redburn, there is a base to build on.

Does Electron House's move herald a full-fledged British invasion? Probably not in the near-term. Other leading British players do not appear to be poised to expand into the U.S. market just now. However, informed sources say they should not be dismissed. Companies to watch include Diploma Plc, Farnell Electronics Plc and STC.

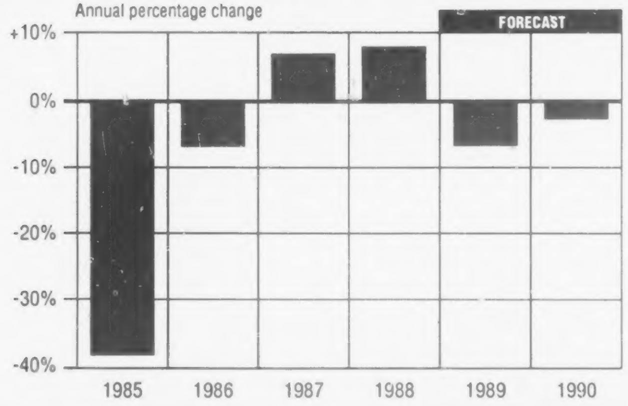
BRUCE RAYNER

Leadtimes in detail

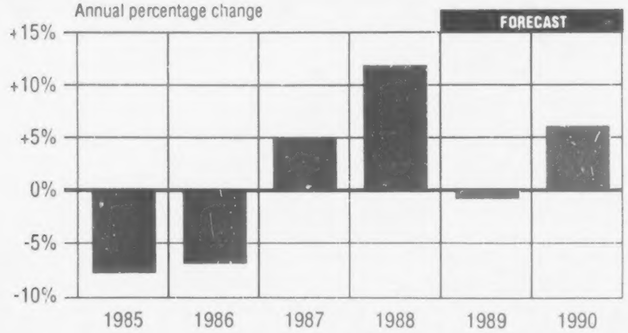
Weeks, monthly averages	1988	1st qtr. 1988	FORECAST 1st qtr. 1989	FORECAST 1st qtr. 1990
Discrete semiconductors	7.1	7.3	7.1	6.8
Integrated circuits	6.9	7.0	6.5	6.4
Memory circuits	13.0	11.0	12.4	8.8
Microprocessors	8.9	8.4	9.1	7.5
Displays	8.2	8.4	9.0	6.6
Capacitors	6.5	5.8	6.4	5.4
Connectors	6.5	6.6	6.4	7.0
Printed circuit boards	5.6	5.6	6.0	5.3
Relays	7.5	6.8	9.8	9.1
Resistors	4.9	4.7	4.5	4.2
Switches	6.2	5.8	6.2	6.3
Wire and cable	3.9	4.0	4.1	4.2

Historical data: Electronics Purchasing; Forecast: Cahners Economics

Electronic component leadtimes



Electronic component production



Historical data: Electronics Purchasing; Forecast: Cahners Economics

Leadtimes falling in early 1989

After a summer of tight supplies for such critical components as memory devices and microprocessors, buyers found deliveries speeding up in early 1989. Still, delivery times for some parts, due to the run-up in leadtimes last summer, continued to remain a bit higher than the previous winter, so buying challenges are not over yet.

Delivery times for memories, after jumping over 15 weeks last summer, had fallen three weeks by the first quarter of 1989. That's good news for buyers, obviously. But the leadtime data indicates something else again for sellers in the component marketplace.

Demand down, supplies up

Slowing delivery times now indicate two phenomena. First, demand for components is slowing. Growth in computer and office equipment shipments may be slacking off a bit in 1989. Other major end users of components may also be slowing.

Second, supplies of some key components are now more accessible as new capacity has come on stream. The 1-megabit DRAM device, which was in short supply last year, will be easier to find in 1989 as yields at fabrication plants improve and new fab sites begin operation. As yields improve, prices of this device are expected to drift downward this year.

The combination of slowing end-market demand and growing supplies is causing delivery times for components to decline. The result: Component shipments will be growing slower in 1989, and may even decline a bit.

Look at the two charts adjacent to this column. The growth path for component leadtimes mirrors the growth path for component production. When leadtimes begin to head down for more than one quarter, chances are production of components will follow some downward trajectory too. Clearly, leadtime growth has passed its peak set last summer. Now, in early 1989, production has also begun to show a downward trend in growth.

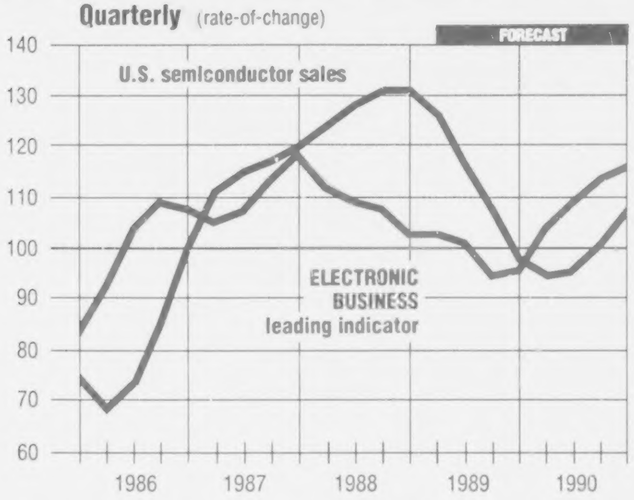
So, while leadtimes mean one thing to the buyer of components, market watchers who need to plan their company's forecast — whether it be computers, communication equipment, consumer electronics or test equipment — may well want to take a second look at the component leadtimes' numbers. In fact, the leadtime statistic is one critical element in the ELECTRONIC BUSINESS leading indicator.

ELIZABETH B. BAATZ

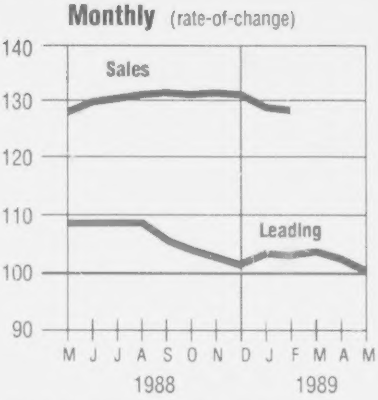
BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368



The ELECTRONIC BUSINESS leading indicator inched up to 102.8 in January, the first significant monthly increase since 1987. This slight upward action doesn't confirm a business cycle point yet, it's just a minor resting period. The indicator is still expected to turn upward this September.

Source: Cahners Economics

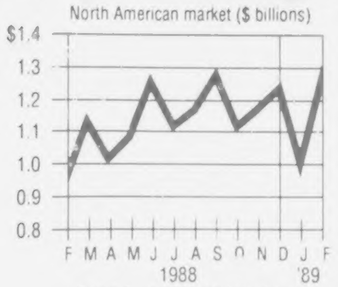
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Jan.)	102.8	101.0	112.8	107.6
U.S. semiconductor bookings ($ millions, 3-month average, Feb.)	$1,243	$1,124	$1,116	$1,178
Weekly hours of semiconductor production workers (monthly average, Jan.)	39.5	40.9	40.5	40.2
Electronic components leadtime index (1977 = 100, March)	117.7	104.0	107.8	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, Feb.)	51.0	49.0	52.9	54.4
Change in electronic components inventories ($ millions, SA, Jan.)	+$52	-$135	+$110	+$80
Contract and orders for plant and equipment ($ billions, SA, Jan.)	$44.6	$43.6	$37.7	$39.4

SA = seasonally adjusted, all other data is not seasonally adjusted

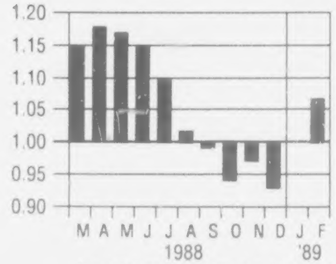
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



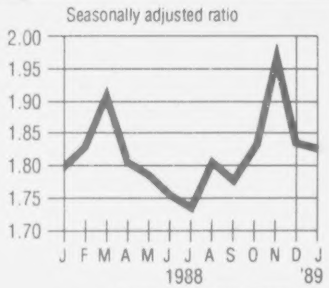
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department

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MAY 15, 1989

WHAT'S RIGHT with America's IC equipment makers? PAGE 28

How to use lawyers to reduce risks PAGE 73

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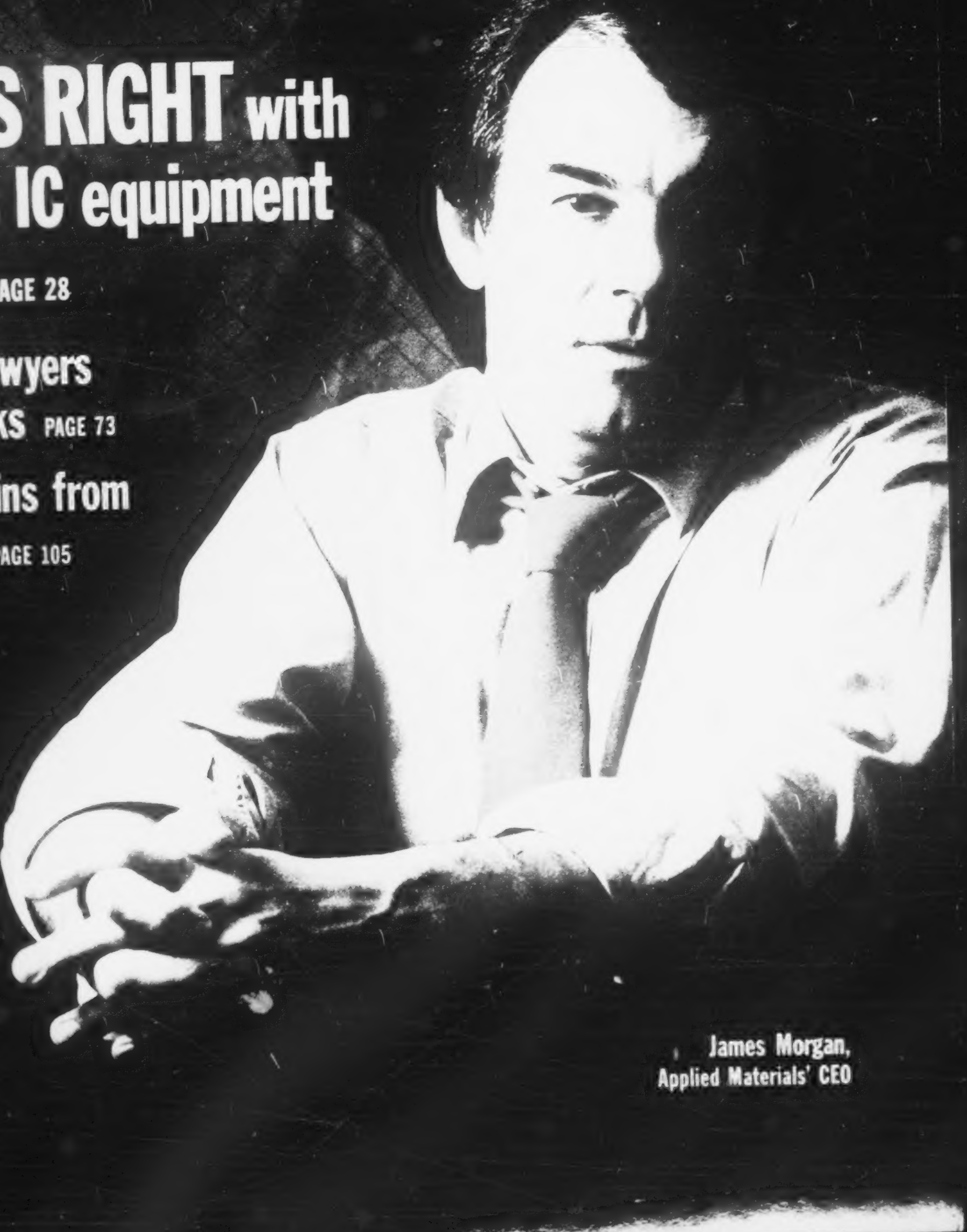

James Morgan,
Applied Materials' CEO

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE
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U.S. semiconductor equipment makers stood at the top of the world 10 years ago, but today they are also-rans to Japan in the race for worldwide market share. They've given away their throne by selling unreliable machines with dismal sales support. They're trying to do better, but recent improvements by some vendors may not be enough to stop them from becoming niche players.

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The U.S. fingers Japan for unfair trading but shies from using the retaliatory power of its Trade Act's Super 301 clause. The dilemma is determining "when to use the crowbar and when to use the handshake."

22 Loud and clear: New ICs boost the FM airwaves

Sprague and Sanyo are actively developing FMX chips needed to produce stronger, clearer stereo sound that ultimately could become as prevalent as Dolby. FMX technology offers great promise for the automotive and consumer electronics marketplaces.

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28 What's right with America's IC equipment makers?

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Cover photograph: Christopher Springmann

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Custodians of quality

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While the job of instilling quality ideals is that of editorial management, the job of ensuring ideals become reality belongs chiefly to our two "vice presidents of quality" — section editor Marvin Greene, who examines the content to make sure that the stories have a point and structure; and copy editor Barbara Jorgensen, who checks on the style to guarantee that the English language is being deployed, not destroyed.

Marvin Greene, section editor

Barbara Jorgensen, copy editor

We're proud of our readability; it's an asset we have to protect in an age when information increasingly arrives as TV and tabloid chatter. Barb and Marvin are very capable custodians of that asset.

Wafer stepper woes

Ten years ago, U.S. firms ruled the world's IC fabs with their wafer steppers and other production equipment. Today, the leading vendors of chip-making equipment hail from Japan. What happened to the U.S. suppliers? As our cover line suggests, we feel the question isn't, "What's wrong with America's IC equipment makers?" but, "What's right with them?"

In our cover story, senior editor Valerie Rice explains how U.S. vendors dropped the ball, and how the rules of the game have changed. There's little doubt that it matters to North American chip makers. But can U.S. equipment vendors can now be much more than secondary players?

JOHN KERR, editor

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What's right

with America's IC equipment makers?

By selling unreliable machines with dismal sales support, they've handed world leadership to Japan. Recent improvements by some U.S. vendors may not be enough to stop them from becoming niche players

BY VALERIE RICE

Ten years ago, U.S. semiconductor equipment companies were on top of the world, looking down on the rest of their competition. Today, they are looking up at the Japanese, who in 1988 captured the three top slots in worldwide market share, according to market research firm VLSI Research Inc.

The health of the equipment makers is inextricably linked to that of their customers, the semiconductor manufacturers. For every point of market share the U.S. semiconductor companies lose, their equipment suppliers lose a half-point, claims VLSI Research. But the reasons behind the malaise facing the equipment makers go deeper than that.

Many equipment companies acknowledge their own weaknesses, citing poor equipment performance, substandard service and general inertia as legitimate reasons for U.S. chip companies to look offshore. Now in a crisis situation, U.S. equipment makers are asking themselves why, and coming up with some uncomfortable answers.

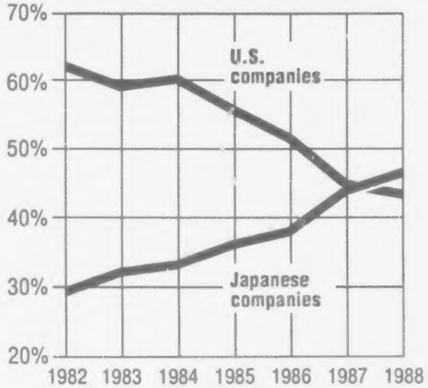
The outlook is not entirely bleak. Equipment companies are now realizing they have to find a road back — and they need their U.S. customers to help them do it. For the first time, the two groups are starting to understand each other better, and the outlook for 1989 is becoming optimistic, for both market growth and fence mending.

That said, there are many who question whether the U.S. makers can ever climb all the way back. Former world leaders GCA Corp., Andover, Mass., have either dropped to the bottom of VLSI's top 10 list or fallen off completely. Still others are calling it quits entirely, witness that the U.S. equipment sector is actively consolidating: in late April, The Perkin-Elmer Corp. announced a major restructuring that put its IC gear unit on the block. And the U.S. share has begun to erode seriously. In 1982, U.S. firms had 62% of the $1.4 billion worldwide front-end equipment market (excluding test and assembly); by 1987, that share dropped to 45% of a $3.1 billion market, according to Dataquest Inc. Meanwhile, Japan went from 29% to 44%.

The bulk of the Japanese growth in the equipment market has come at the expense of the U.S. wafer stepper industry. Wafer steppers are a large chunk of the equipment market — currently about 32%, according to VLSI Research. The U.S. remains strong in areas such as ion implantation, epitaxy and sputtering.

U.S. suppliers' downhill slide

Share of worldwide market for front-end IC production equipment



Source: Dataquest Inc.

But some industry experts fear that wafer steppers may be just the beginning for the Japanese, who have cranked up a high-caliber industry of their own in Japan, and may be looking to move into other U.S. equipment markets. However, the U.S. semiconductor makers have reason to fear dependence on the Japanese for production equipment.

"There is no way we can survive without an indigenous U.S. equipment base," declares Melbourne, Florida-based Harris Corp. semiconductor executive vice president Jon Cornell. "We would be history without it. If we can't get U.S. equipment and materials, we will be out of luck," stresses Cornell. Complete dependence on foreign production equipment could bring the U.S. semiconductor

Christopher Springmann

industry to its knees, Cornell speculates, because the key process technologies would be in the hands of their main competitors.

Structural failure

The most obvious problem with the production equipment industry, and the most difficult to solve, is that it is not structured to be successful. The Semiconductor Equipment Materials Institute (SEMI) estimates there are 800 equipment companies in the United States, with average sales of $7 million per year, competing for a world market for front-end equipment that Dataquest says was worth only $4 billion in 1988. With purchasing patterns shifting toward larger, more stable companies and the market operating on an international basis, it is difficult to envision how small companies without extensive resources can survive.

Yet they *are* surviving. Despite the trend toward consolidation, the number of companies in the industry remains substantially the same, according to VLSI Research. Last year, however, some market research estimates suggest 26 companies merged, were acquired, or folded.

Regardless, the U.S. equipment industry is often its own worst enemy by aiming for short-term profits. Since U.S. investors frequently focus strongly on highly variable quarterly financial results, many U.S. production equipment makers often have difficulty in raising long-term capital to fund new development.

> **"There's too much focus on short-term results. You end up with companies that look good but have no staying power. . ."**
>
> **Applied Materials' chairman and CEO James Morgan**

"There's too much focus on short-term results," says Santa Clara, California-based Applied Materials Inc. chairman and CEO James Morgan, of the equipment industry as a whole. "You end up with companies that look good but have no staying power." Morgan refers to these companies as the "living dead."

So it's doubly difficult to compete with "Japan Inc." and its long-term mentality, notes Greg Reyes, president of American Semiconductor Equipment Technology Inc. (ASET), the Woodland Hills, Calif., wafer-stepper vendor. "By definition, we are behind the eight ball no matter what we do," he declares.

Those complaints U.S. chip makers have heard frequently. "The U.S. equipment vendors complain tremendously about how unfair things are," notes one.

Size is another major problem. With so many small companies, it is difficult to get the critical mass needed to make the sales. In fact, it is often impossible to get the resources needed just to survive the sales cycle, which can run upward of 18 months.

In this "very international marketplace today, you want to pick a vendor with worldwide presence," says Joe Grenier, director of semiconductor equipment and materials service at Dataquest. "Small companies have a difficult time getting worldwide presence, and if they don't get the sales, they don't have research and development money. In this industry, R&D money is critical."

But one U.S. company has been notably successful in

American Semiconductor Equipment Technology's president Greg Reyes: "By definition, we are behind the eight ball no matter what we do"

Ed Glendinning

weathering the sales cycle. Applied Materials is one of the largest U.S. equipment suppliers, with fiscal 1988 revenue of $363 million. Most analysts credit CEO Morgan, a former venture capitalist, with the management expertise and foresight to survive — and actually prosper. Morgan says the secret was the philosophy that "... what we were doing transcended the ups and downs of the industry." In 1985, 1986 and early 1987, he says, Applied was just breaking even, but it still kept R&D spending as high as 18%. That amounted to some $30 million on R&D, according to Morgan.

The results speak for themselves. Applied has a well-diversified business with over half of its sales overseas, and is considered one of the best managed companies in the equipment industry.

But for small companies, the luxury of $30 million in R&D is impossible. "Say you're willing to invest 15% of your sales in R&D, and your sales are $20 million," explains Morgan. "That's $3 million, which means you do one product. Compare that to a company that's spending 10 times that. It's hard to compete with. It's hard to build up enough base to spend with."

"There are very few companies today that can afford the cost of development [on their own]," says Barry Cox, president and CEO of reticule maker Ateq Corp., in Beaverton, Ore. "Companies with less than $10 million in revenue won't be able to continue in the coming years," Cox says.

Customer or adversary?

The biggest complaint on both sides of the issue is that the industry is not structured like the Japanese model, which is held to be the yardstick by which all things are measured.

"There will be niches for U.S. IC gear makers"

U.S. chip CEO

In Japan, equipment companies do exactly what their customers tell them, VLSI Research president Dan Hutcheson says. And if the Japanese can find a locally made product that is acceptable, they do not go offshore. In the United States, there is very little communication, and the resulting products are often less than satisfactory. And U.S. chip companies buy a lot of foreign equipment — as much as 60% of the total installed base in some companies.

Reyes blames the U.S. chip customers. "These guys have no loyalty," he snaps. "If the U.S. would have operated on the same set of rules as the Japanese, we would not be in this situation today."

And although both sides are now talking more, the erosion continues. At Cypress Semiconductor Corp., San Jose, president T.J. Rodgers instituted a "Buy U.S." plan from the beginning, and is proud that 85% of his currently installed production equipment is U.S.-made. "We never buy foreign equipment unless we are forced to," he explains, "and it didn't happen at all in the first two or three years. But now it is happening more often. When we went to buy steppers, we ended up with Dutch steppers, because GCA was on the ropes. It's no longer a U.S. game." That's largely because U.S. vendors could not supply the most sophisticated models, adds Rodgers.

At Intel Corp., approximately 70% of the installed capital equipment is American, says Andrew Grove, president and CEO. "When we can, we try and buy American, but you have to be realistic," he stresses.

"U.S. companies have historically made dense devices but not addressed the manufacturing discipline," says Franc deWeeger, president of Advantage Production Technology, of Sunnyvale, Calif., a maker of chemical vapor deposition equipment. "The equipment industry has always been much maligned, but rightfully so in some cases. The equipment shipped often had poor uptime, and once it was shipped it was impossible to support."

Downtimes of 15% and more, even on wafer steppers, have not been unusual; customer support has often been deplorable. Bill Healey, senior vice president for operations at ASIC maker Silicon Systems Inc., Tustin, Calif., [now being acquired by TDK Corp.] cites examples of machines that could be down for a week, even after they'd gone through lengthy service discussions by phone with the vendor's technicians. "That's totally unacceptable," says Healey, who says he now looks for the vendor's technician the next day at worst.

There's even more urgency at SGS-Thomson Microelectronics America Inc., Scottsdale, Ariz., where the goal

Finding offshore success: Applied Materials in Japan

Just when it looks like the Japanese are running roughshod over U.S. semiconductor equipment companies, enter Applied Materials Inc., Santa Clara, Calif.

With more than $135 million in sales in Japan in 1988 (out of total fiscal sales of $363 million), Applied is one of the largest U.S. suppliers to Japan.

And the company is living proof that the Japanese don't completely dominate the market.

"If Applied is doing so much business in Japan, that's some indication that the Japanese aren't doing that well," says former Applied senior vice president Robert Graham, now president and CEO of San Jose start-up Novellus Systems Inc.

Applied had an 18.3% share of the Japanese chemical vapor deposition market in 1988, according to market research firm Dataquest Inc., and a 57.7% market of the epitaxy market. Those figures are dramatically larger than the corresponding 1982 numbers of 11.8% and 33.5%, respectively.

If there is a formula to Applied's success, it is that chairman James Morgan saw the advantages of moving into foreign markets, like Japan, early on.

"There was not very much momentum going at Applied when I started in 1971," Morgan says. "The way I saw it, we needed to go direct into Japan, so we hired a local Japanese person. We focused on supporting him from wherever he needed support, so he could develop a Japanese company not totally dependent on indigenous resources."

Applied has been so successful in Japan that "we gained market share during a downturn," Morgan brags.

But it is still tough to break into Japan. Morgan notes that the Japanese "first preference is to buy within the family of companies. The second preference is to buy from another Japanese company and the third preference is to buy overseas." The key for Applied was knowing the market — and its customers. "We tried to get close to customers both Japanese and non-Japanese," he says. That's important, because Japanese companies want a product tailored to their needs, Morgan stresses. "If somebody local tailors it better then they are going to get the business."

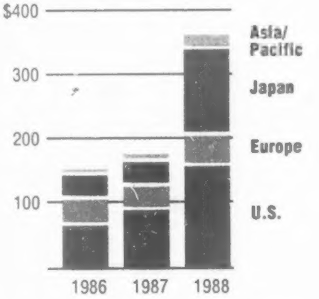
"You have to look like a Japanese company," he adds.

This understanding of service has been the backbone of Applied over the years, particularly in Japan, says Semiconductor Equipment and Materials Institute executive director William Reed. "The ability of Americans to respond to the need for service has been greatly misunderstood. Morgan understood service, but we still have some companies that are lax."

"Applied has partnered very well with their vendors and customers," says Dataquest's director of equipment and materials service Joe Grenier. "They have the best presence of any American company in Japan." □

Applied's Far East push

Applied Materials' fiscal year sales by region ($ millions)



Source: Applied Materials Inc.

is for equipment to be up and running again inside six hours.

And even Japan's detractors would agree that country's IC makers are strong in manufacturing. So, as semiconductor makers began to fall behind the Japanese, it seemed only natural to seek out Japanese equipment to help give them a competitive advantage, asserts VLSI's Hutcheson.

Ironically, however, the perception of Japanese equipment is often far better than the reality, at least according to Hutcheson, who conducts user preference surveys yearly. In 1987 (the most recent year for which data is available), Nikon Precision Inc. had a preference rating of 8.5, on a scale of 1 to 10, compared with U.S. competitor GCA, which had a 7.0. In terms of actual, measurable uptime, however, Nikon and GCA were tied at 93.2% in 1987.

Perception here is everything, according to Hutcheson. "There is prestige in owning Nikon," he claims, "and in the early days, like in 1985, people would still rate Japanese equiment better even though they didn't have any themselves. Usually it was because they owned a Nikon camera." So now that the Japanese have penetrated the market so extensively, Hutcheson is hoping that perception and reality will begin to merge.

For a long time, U.S. equipment companies and their semiconductor partners wouldn't talk to one another. Now a declining market situation has forced their hands, making uneasy partners of former adversaries. U.S. companies are trying to live down their reputations by asking their customers what they need.

"Fundamentally, the problem is that we don't understand each other's businesses," says GCA president Peter Simone. "We're starting to talk with each other. It's a lot better now than it used to be." As examples of the improvement at GCA, Simone cites regular user meetings, a user newsletter, and a growing awareness of increased support requirements.

And Simone says his production-driven strategy has worked. GCA has come back from the "living dead" over the past two years, and Simone stresses that the company is "now making production worthy equipment. We weren't really doing that before."

Despite some positive changes, some semiconductor customers remain skeptical. LSI Logic Corp. president George Wells asserts that the equipment industry refuses to face reality when told that their equipment must not break down — and must constantly improve. "The Japanese do a better job than the U.S. in keeping equipment up," he says. "It's sad but that's the problem. There are a fair number of people in the equipment business who have a real disbelief in the kind of performance requirements we ask of them." The bottom line, Wells believes, is that equipment companies "need to do better." In the meantime, LSI Logic gets 60% of its equipment from Japan.

Better equipment and better service are intertwined, according to Novellus Systems Inc. president Robert Graham, who previously spent years with Applied Materials. Graham says that production equipment from U.S. vendors "was designed to demonstrate technology, rather than for inherent reliability."

"The Japanese are very intent on having things run all the time," says Graham, whose San Jose company manufactures chemical vapor deposition systems. "They lose face if their systems go down." Graham says that Japanese companies also put more emphasis on — and resources into — providing service. "The Americans just won't do it."

Perception and reality

VLSI's Hutcheson agrees. "In the early days, when U.S. companies were selling equipment in Japan and the market turned sour, they had to cut back on service. The Japanese vendors came in and hired those service technicians, and then the perception that Japanese equipment was better became reality."

One reason the Japanese do so well in service is their insistence on service contracts. Nikon, for example, requires that customers purchase a service contract or the company will not sell the machine, Hutcheson says. Thanks to that contract, Nikon has a repair time average of three hours, and an 8 out of 10 rating from customers for post-sales support. Nikon guarantees 93% uptime for its wafer steppers. In the United States, Nikon's service and technical support staff grew more than fourteenfold between 1984 and 1988.

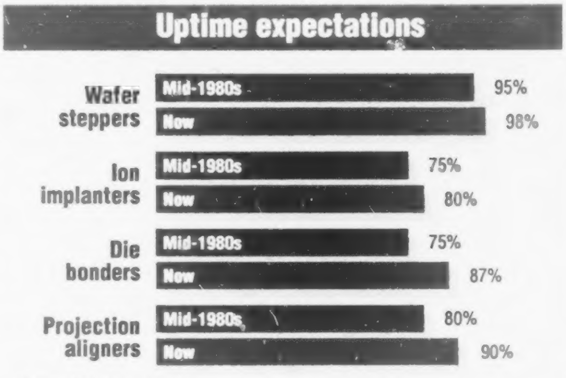
In comparison, GCA, which Hutcheson estimates has only 30% to 40% of its customers with service contracts, has an average repair time response of 11 hours, and a rating of 5.7 out of 10.

Varian Associates Inc. is fighting back in this arena, by elevating customer service to "the same status as manufacturing," says semiconductor equipment group president Tony Jurvetson. "They report directly to me."

Good service applies just as much to the back end as to the front. Ideally, says Hans-P. Kurner, general manager of the U.S. arm of Swiss die and wire bonder maker ESEC SA, service would become obsolete, and one way to head in that direction is to reduce operator involvement by designing the machine around software. That way, recalibration by humans for different jobs is minimized, errors drop and set-up times improve.

The SEMI/Sematech solution

While equipment companies have been pushing for closer customer relationships with chip companies, the semiconductor companies have been doing some pushing of their own. Equally beleagured by the Japanese, semiconductor companies have come to the realization, rather late in life, that an indigenous equipment industry is vital to their long-term health.



Source: Industry estimates

While IC makers cite strong improvement in reliability from many of their U.S. equipment vendors, they add that the improvement is far from universal and often still not enough

This intertwined relationship, and its implications for the future of the chip industry, was compelling enough to drive the semiconductor makers, after forming Sematech, the industry R&D consortium, to establish another R&D partnership with the equipment companies association, SEMI.

Hailed by both sides as a very positive step toward recovery of the U.S. industry, SEMI/Sematech is structured to provide technical access and small amounts of funding to equipment companies winning bids on research and development projects.

Once the products are developed, SEMI/Sematech bid winners are almost guaranteed a steady source of revenue — first from Sematech members, and then from any other company wanting access to designated state-of-the-art technology.

The problem, of course, is the risk of a "Rich get richer and the poor go out of business" syndrome, in which the bid winners will consistently be from larger companies less in need of an R&D boost.

Novellus' Graham believes that the intent of Sematech is good, but "the methodology is wrong. You don't want to give development money to large companies who already have it, but entrepreneurial companies with good ideas who need it."

With the large number of players in the U.S. equipment market, it is impossible to satisfy all the companies, and SEMI/Sematech group president Sam Harrell does admit he runs the risk of playing "kingmaker."

GCA's Simone notes that "Sematech has to make choices. They can't buy everyone's equipment, so they are going to have to make difficult choices."

One equipment executive who declined to be named says his company is participating in SEMI/Sematech, but is not sure what good it can do. The large company mentality of the semiconductor members does not seem conducive to getting small equipment companies involved, the executive argues, so it may be a waste of his company's time, energy and money. The equipment people are not "standing up to the chip people," the executive says. "They are little more than errand boys for the semiconductor companies. How can unknown companies break in without some extra help?" the executive asks.

Sematech could also be too little, too late to help the equipment companies. The Joint European Submicron Silicon Initiative program in Europe is cited as one example, the funding of which (reportedly $4 billion total with $500 million just for equipment) makes Sematech's overall $200 million budget look small.

SEMI executive director William Reed is not sure what all the fuss is about. He argues that Sematech is just one possible solution to the U.S. equipment industry's woes, and notes that there are other options available.

The new purchasing order puts the squeeze on smaller vendors

Daniel Queyssac, president of Scottsdale, Arizona-based IC maker SGS-Thomson Microelectronics America Inc., recalls a previous job, a decade ago, when a major piece of IC production gear was talked about in an operations review and decided upon by the meeting leader with the immortal line: "Why don't you buy one?"

IC equipment vendors wish it were still that easy. But with more and more riding on the choice of process gear, semiconductor makers are turning their purchase decisions into committee activities — often headed by a top executive — and formalizing the buying process like never before.

Whereas Queyssac's former colleagues chose the gear in a couple of months, today it takes at least a six-person team over a year to choose something as crucial as a wafer stepper.

The new purchasing mode puts the squeeze on smaller vendors, and imposes tough new demands not only on the performance and reliability of their equipment but on their after-sales service.

"Buying has been made much more sophisticated," says Dataquest Inc. equipment and materials service director Joe Grenier. "Companies are not so willing to experiment with start-ups. They want proven companies."

Case in point is Bipolar Integrated Technology Inc., a Beaverton, Ore., maker of fast VLSI devices. In its earliest days — BIT was incorporated in 1983 — the company bought on cost, often buying from smaller IC gear makers. CEO Stephen Cooper admits to having been burned that way, so BIT's approach now is to go with proven vendors.

Others have firmed up their equipment sourcing by trimming the number of vendors. At Silicon Systems Inc., a Tustin, Calif., maker of ASICs, senior vice president of operations Bill Healey points out that his vendor list has been pared by over 30% in recent years to only those that can meet stringent after-sales service commitments.

Meanwhile, Healey now looks for his broken equipment to be working again inside eight hours — not the week that it could be out of action just five years ago.

Buying IC gear today:
Procrastination's out;
prenegotiation's in

Typical prenegotiation points

- Guaranteed minimum uptime
- Guaranteed on-line time
- Extended warranty
- Guaranteed spare parts prices
- Guaranteed spares availability

Refined purchasing techniques are taking the place of the rush buy. Amid the turmoil of the mid-1980s IC downturn, National Semiconductor Corp., Santa Clara, Calif., opted to make the purchasing department fully responsible for equipment buys at any of its facilities, a move that offers more consistency and treats the vendor more like a partner than a servant.

"When you buy a major piece of equipment, it's not just a one-off deal. It's damn near like a marriage," says director of purchasing James Critzer.

These days, Critzer's department sets out a master agreement with potential vendors once early projections of IC demand have been met — not when the need for a machine is desperate. "Prenegotiating" outlines parameters like: guaranteed time to get the machine up and running; guaranteed minimum uptime; extended warranty; and spare parts prices over the life of the machine.

"We want a guaranteed seven-year supply of spares. You want to define these things up front," says Critzer. In the bad old days, he adds, the conventional purchase order never even touched the issue of uptime. Later, after a specific item of equipment has been decided upon, the request-for-proposal tackles actual engineering specs in detail. ☐

"Sematech is only $200 million," he says. "There's an awful lot of money available for research and development out there. I don't know why people are so upset."

Reed says that DARPA (Defense Advanced Research Projects Agency) is funding $450 million in semiconductor device research alone. Combined with an estimated $650 million in R&D investment from SEMI members, and $700 million from semiconductor device vendors, he says $1.8 billion is being devoted to device research as a whole.

And there are opportunities for equipment companies to participate in the DARPA research projects. For example, the University of Southern Florida's Center for Microelectronic Design has an estimated $30 million research budget just for semiconductor equipment.

With funding sources and a few more receptive customers, equipment makers believe that they might be on the comeback trail to success, once again. And most semiconductor vendors would agree. "Things are getting better," says a National Semiconductor Corp. spokesman. "The equipment makers are making more of an effort to give us what we need." "We can compete right now in all other areas besides steppers," states Applied's Morgan, with the confidence of the successful.

SEMI's Reed would even argue that the United States is not dead and gone in steppers. Citing the potential of the high definition television market, Reed says "the market is wide open. There is no reason the U.S. can't come back in wafer steppers. HDTV will open up tremendous new avenues for our members. All the process equipment used to produce the chips is also needed to produce the flat panel displays."

Small stepper player ASET has had bottom-line benefits from high definition television — and other niches. "We put a lot of effort into it and sold three machines into the high definition television areas," Reyes says. "But in the volume stepper market we are having a tough time. We want to stick to niches rather than a frontal strategy."

The key to the U.S. comeback in the equipment business seems to be in focusing on the small battles, rather than the large wars. Like HDTV, other niche market opportunities will present themselves in new process technologies such as BiCMOS and gallium arsenide, and equipment companies must be prepared to anticipate these trends.

At GCA, Simone, when asked what he could have in this industry that he doesn't have now, says only "a big purchase order." Seriously, Simone believes that a renewal of the equipment business will only happen when his customers are willing to partner with him on products that might not be state of the art right now. "There will be no long term without a short term," he says. "We have to first get to break even."

The verdict from many IC makers is mixed. There is widespread agreement that U.S. gear vendors have cleaned up their acts considerably on everything from equipment reliability to technician training. "Their whole attitude on service has really changed. They want to know about the problems. I haven't had to call [GCA president] Peter Simone in a long, long time, which is just head-and-shoulders above what it was," says James Critzer, director of purchasing at National Semiconductor Corp., Santa Clara, Calif.

It's the same story at SGS-Thomson. "Five or six years ago, you could not find any supplier that was willing to give a guarantee of 85% to 90% uptime. Now you have some suppliers who will guarantee at least 95%," says president Daniel Queyssac.

The key word there is "some." While users cite strong improvement from many of their U.S. vendors, they add that the improvement is far from universal and often still not enough. And that defines the future for the U.S. semiconductor production equipment industry. The bigger firms that have made the commitment to quality and service are already showing strong survival instincts, but many smaller players may never get the financial resources *and* provide enough value-added to get ahead.

But the road back will be tough. Says Stephen Cooper, CEO of fast VLSI firm Bipolar Integrated Technology: "I believe there will be niches for the U.S. IC production equipment makers. Overall, I have little hope that they will dominate again any time soon."

South Korea offers a window of opportunity

If Japanese and U.S. markets appear too crowded, American IC equipment makers might look more closely at South Korea.

"Right now, Korea is buying more than Europe," says Dan Hutcheson, president of San Jose market research firm VLSI Research Inc.

With an IC production output that follows the curve from $2.3 billion in 1987 to $3.2 billion last year, and a government that is eager to head off the kind of friction that is souring U.S. trade relations with Japan, Korea holds plenty of promise — if its chip makers can be convinced that U.S. equipment and support is just as good as what they get from Japan.

Korea's semiconductor makers (chiefly Goldstar Semiconductor Co. Ltd., Samsung Electronics Co. Ltd., Hyundai Electronics Industries Co. Ltd. and Daewoo Electronics Co. Ltd., the IC operations of the four *chaebol*) last year spent about $370 million on production equipment, according to Domicity Ltd., a Toronto-based management consultancy that recently examined Korea's electronics base.

Among the bigger outlays listed during a recent Korean trade mission to the United States: Hyundai plans to spend about $60 million on furnaces, sputtering systems, etchers and other gear.

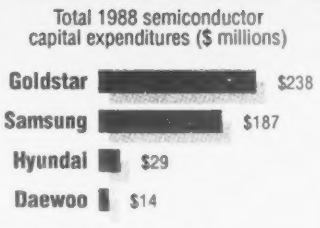
Korea *has* to buy from abroad — for now. "The Korean semiconductor equipment industry is very undeveloped. This is the greatest weakness of the Korean IC industry as a whole," explains Marc Brien, Domicity's director of research.

Until Korea gets up to speed, though, the market belongs to foreigners. Domicity, citing recent interviews with executives from Hyundai's plant in Ichon, about an hour's drive from Seoul, indicates that the balance may be in the favor of U.S. companies for now. Of Hyundai's overall base of IC equipment, 40% comes from Japan and 60% from the United States.

Specifically, 80% of the test equipment is sourced from Japanese firms Ando Electric and Advantest Corp., while all of the diffusion furnaces come from the United States and 80% of the wafer steppers are U.S.-made.

The window of opportunity is now — for two distinct reasons. First, notes Domicity, the Japanese are extremely hesitant to transfer technology to Korea's *chaebol*, and this lack of access appears to be reflected in buying patterns.

Capital expenditures by Korean chip companies



Conversion rate: 748 won = $1

Source: Korea Economic Daily

Second, much of Korea's nonproprietary process technology is American, and many of its purchases are made to fulfill OEM/foundry contracts — many of them with U.S. firms.

That's a bias that American equipment vendors are keen to capitalize on. Varian Associates Inc., Palo Alto, Calif., already sources a "substantial" portion of its IC equipment sales from Korea — the result of a presence there since 1975 and a joint venture that began in 1984. Varian also carries out some production there through its Varian Korea Ltd. operation. "We are getting double-digit orders from them," says Tony Jurvetson, president of the semiconductor equipment group.

And GCA Corp. is actively eyeing opportunities to sell into South Korea's semiconductor manufacturers.

But an indication of Korean chip makers' future preferences may be seen in other comments gleaned by Domicity. Hyundai cites Nikon Corp. as the maker of the best steppers: although a little more expensive, the Nikon units run all day without the two-hour reset intervals required by the U.S. counterparts that Hyundai's Ichon plant runs.

Those reports confirm the general dissatisfaction of Korean chip makers with U.S. equipment support reported last year [ELECTRONIC BUSINESS, June 1, 1988].

Semiconductor equipment spending to grow steadily

The roller-coaster cycles of the past two decades are over for equipment suppliers as IC makers move ahead cautiously

BY MARK MEHLER

The boom-and-bust days are gone, at least for the present. 1988's $8.7 billion worldwide semiconductor equipment industry, after two decades on that bumpy road, is on a kinder-and-gentler slope this year.

While the industry won't come close to matching its 55% to 60% annual growth rate last year, last fall's common wisdom — that an economic recession would drag the market in a negative direction — is now widely discounted. Market researchers, equipment vendors and IC makers now project anywhere from 8% to 13% growth in equipment revenue in 1989, and a solid 7% to 8% growth in bookings, a healthy harbinger for 1990.

"I think the equipment industry, the front-end and back-end systems houses, will have a reasonably good year," says Jim Feldhan, vice president of Scottsdale, Arizona-based In-Stat, a market research firm. "We've just raised our 1989 U.S. semiconductor sales forecast from flat to 2% growth to 13% growth, and worldwide shipments should be up more than that. There is still a lot of strength in the personal computer and telecom markets." Feldhan adds that Japanese semiconductor makers and the biggest U.S. capital spenders plan to bring on new memory, ASIC and microprocessor capacity over the next two years.

A minimum 8% to 10% worldwide equipment revenue growth in 1989 is forecast by Daniel Hutcheson of VLSI Research Inc., a San Jose firm that tracks the IC systems business. Hutcheson cites an economy that's steaming ahead, continued weakness in the dollar that is spurring U.S. OEM exports, and the rapid transition from bipolar to advanced CMOS and BiCMOS.

Similarly, a 12% increase in worldwide equipment shipments this year is predicted by Joe Grenier, director of semiconductor equipment and materials services at Dataquest Inc., a market researcher. However, Grenier considers this a pessimistic forecast ("anything under 20% annual growth in this market is disappointing"), but others take a more positive view. "Going back 16 years to the early 1970s," advises Pat Lamey, vice president and general manager of KLA Instruments Corp.'s wafer inspection division, the equipment industry's average annual growth, adjusted for inflation, is only 14% to 15%. Therefore, looking at it in that light, 10% or 12% growth this year, in a low inflation climate, doesn't look bad at all.

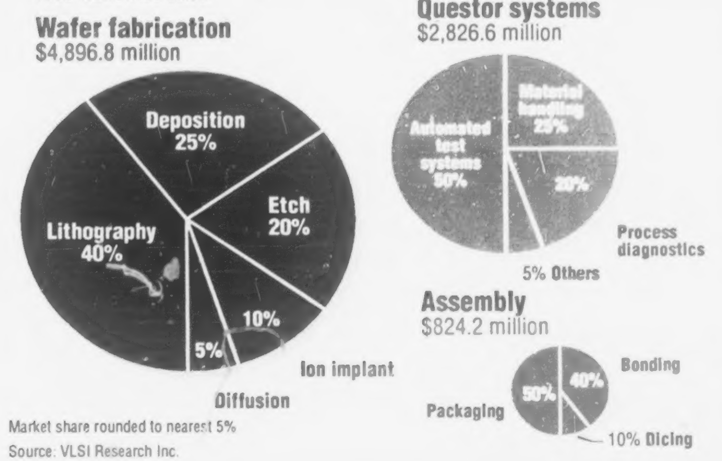
Can't match 1987-88

It would be unreasonable, say several observers, to expect the industry to continue its 1987-1988 growth spurt, the genesis of which was the failure of the U.S. and Japanese semiconductor manufacturers to make significant capital investments in 1985-1986. In late 1987, with the PC market taking off and demanding oodles of memory, the IC industry woke up to a manufacturing nightmare. Having made the transition from 256K to 1Mb memories, where yields were terrible, they couldn't supply either part in quantity. Hence, the capital equipment buying frenzy of last year.

But more spending is to come. James Bagley, chief operating officer of Applied Materials Inc., Santa Clara, Calif., a maker of etching, ion implantation and chemical vapor deposition systems, says Japanese memory houses, having ramped up

Semiconductor production equipment market

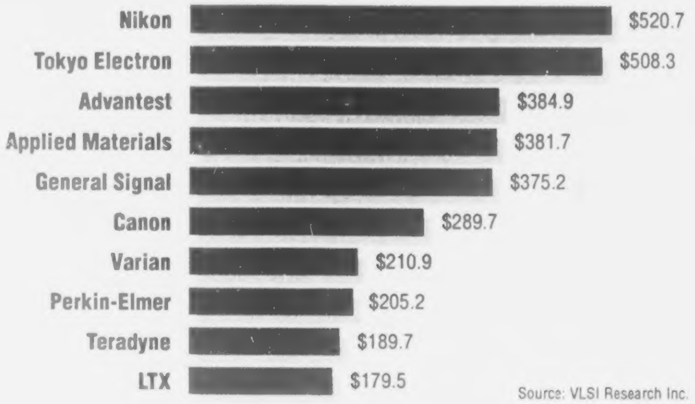
1988 worldwide sales



Market share rounded to nearest 5%
Source: VLSI Research Inc.

Top semiconductor production equipment makers

Estimated 1988 worldwide calendar year sales ($ millions)



Source: VLSI Research Inc.

1Mb production last year, soon will begin investing in 4Mb technology, and in high-performance CMOS processes for fine-line ASICs, microprocessors and advanced logic. Bagley says 4Mb equipment purchases, plus some "final line balancing" of 1Mb capacity, will raise Japanese merchant capital expenditures 15% above 1988 levels.

The U.S. picture is cloudier. The buying patterns are still very selective, but improved book-to-bill ratios earlier this year and plenty of activity on the part of the biggest IC producers — IBM, Motorola Inc. and Texas Instruments Inc. — are reasons for optimism. On the downside, other key players, such as Intel Corp., have delayed expansion programs because of bookings problems, and there remains an overall air of caution in the marketplace. Applied's Bagley estimates capital spending by U.S IC makers to be up 5% to 10% in 1989.

Semiconductor manufacturers, for their part, are typically tight-lipped about their future purchasing plans. A spokesman at National Semiconductor Corp., in Santa Clara, Calif., for example, says that for the fiscal year ending in May 1989, National will spend approximately $250 million, 25% more than in fiscal 1988 and two-and-a-half times more than in 1987. All the spokesman would say about fiscal 1990 is: "We plan to spend less than current levels."

Those announcing new fabrication facilities over the next couple of years include: TI, a $250 million memory and ASIC plant in Italy under construction; Mitsubishi Electric Corp., a major facility in North Carolina; NEC Corp., an expansion of its Roseville, Calif., capacity; and Motorola, upgrade of a CMOS facility in Phoenix. Continued good news on the book-to-bill and interest rate front should bring additional announcements this year.

Stakes are higher

Nevertheless, in a more moderate growth environment, the emphasis naturally shifts from simply filling the pipeline to the ability to measure up to the rigorous demands of submicron CMOS wafer processing. VLSI Research's Hutcheson looks for the following types of companies to prosper at 0.8-micron to 1.0-micron technologies: vendors with the latest optical lithography tools and the latest generation chemical vapor deposition systems, for exposing and depositing metals in narrow spaces; diffusion furnace makers benefiting from the gradual shift from 6-inch to 8-inch wafers, which will require a major retrofit; and suppliers of advanced wafer linewidth and overlay measurement equipment. KLA's Lamey adds another requirement for doing business in the United States over the next two years: availability of flexible system software enabling ASIC suppliers to make rapid product changeovers.

The long-term view is that Japanese IC makers will continue outspending their American counterparts

Meanwhile, as higher capital costs have raised the stakes in the semiconductor market, IC makers have begun to reevaluate their equipment suppliers, putting much greater emphasis on vendor financial stability, service and support capabilities and reputation for reliability. Again, in a moderate growth climate, these trends, says Hutcheson, are likely to accelerate, resulting in more shaking out among the smaller equipment companies.

Longer term market observers see sustained growth for those equipment suppliers with the right tools and the financial wherewithal to service and support them. Prospects look particularly good outside the United States. The requirement by the European Community to produce chips in Europe and the emergence of an integrated European market in 1992 bode well for equipment vendors. William Reed, president of the Semiconductor Equipment and Materials Institute, says this rosy future could be glimpsed in the record turnout in March at the SEMICON/Europa equipment exposition in Zurich, Switzerland.

Also, the long-term view is that Japanese IC makers, which currently spend an average of 15% to 16% of revenue on capital equipment (vs. only 12% to 13% for U.S. semiconductor firms) will continue outspending their American counterparts. Kulicke & Soffa Industries Inc., Willow Grove, Pa., a major U.S. supplier of wire bonders, die bonders and other back-end chip assembly equipment, recently responded with a realignment of its Asia/Pacific engineering team, assigning a senior person to manage that key operation.

"It seems that they (Japanese, Korean, Taiwanese IC makers) have more confidence in the future and are willing to make a continued investment in new capacity," says Kulicke & Soffa president Don VanLuvanee, who adds that the U.S. equipment company's toughest competition now comes from such Japanese assembly systems makers as Disco and Shinkawa.

But more than marketing is required to compete with domestic makers in the Japanese and Pacific Rim marketplace. "I think every American company has to do a better job of engineering equipment for the Far East market," VanLuvanee says. ☐

Pyramid rights its course and now enjoys the party

This leading-edge computer company parlays Unix, focused marketing and conservative fiscal management into a 45% annual growth rate

BY RICK WHITING

While other companies were holding staid ballroom receptions at the UniForum trade show in San Francisco in March, Pyramid Technology Corp. rented a downtown disco and threw itself a Hollywood-style bash — complete with a Marilyn Monroe look-alike and search lights — to debut its new generation of computers.

Pyramid has always done things differently. And by zigging during the early 1980s when most computer vendors were zagging, the company finds itself at the leading edge of several industry trends: the growing acceptance of Unix and RISC for commercial applications; the move away from proprietary systems to "open" or standards-based products; and the evolution toward networks of desktop computers linked to database servers.

Pyramid's financial figures reflect the success of its visionary strategy. Sales grew from $17.5 million in the first quarter of fiscal 1988 to $24.5 million in the first quarter of fiscal 1989.

Pyramid's foundation, however, has not always been so rock-solid. Already weakened by what industry observers saw as a lack of market focus and an over-emphasis on "hot-box" technology, the Mountain View, Calif., company's growth stalled when a recession hit the computer industry in 1985-1986.

Today, with as much emphasis on tightly focused marketing and conservative fiscal management as on leading-edge technology, Pyramid is riding an annual growth rate of 45%. And the steps taken by Pyramid's management to right its course provide lessons for smaller companies looking to play in markets dominated by industry giants.

"I think they have a better feel for who they are and where they fit," says Jeanette Sill-Holeman, a senior analyst at InfoCorp, a Santa Clara, Calif., market research firm. "They're playing at the high end and that is where the growth is."

Jumped on Unix bandwagon

Founded in 1981 by software developer Rob Reagan-Kelley and Rolm Corp. sales executive Edward W. Dolinar, Pyramid's plan was to be among the first to jump aboard what was expected to be a Unix bandwagon. "Unix was not a product from any one vendor, but a demand pull from customers," says Dolinar, now Pyramid's executive vice president. (Reagan-Kelley left the company last year to pursue an advanced degree.)

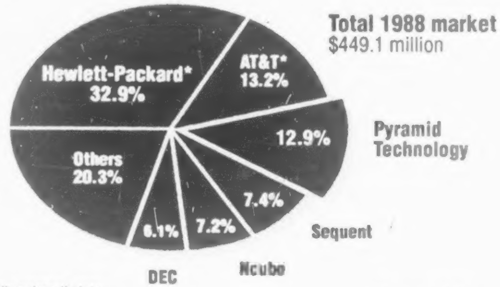
Technological breakthroughs in the company's early days included the first superminicomputers to incorpo-

Kim Frazer

Pyramid chairman Richard Lussier, right, tapped Edward Scott Jr. as marketing vice president in an effort to make departments more accountable

1988 U.S. midrange Unix market

U.S. Unix market for commercial and noncommercial systems with average selling price of $200,000 to $350,000



* Sells primarily into noncommercial markets

Source: InfoCorp

rate RISC (reduced instruction set computer) technology (1983) and the first dual port of the AT&T and Berkeley Unix operating systems (1984). And Pyramid was among the first to recognize the industry evolution toward distributed computing.

Pyramid recorded a profit of nearly $3 million on sales of $33.9 million in fiscal 1985. In December of that year the company went public with an offering price of $16.75 per share.

But Pyramid found itself unprepared when the industry slump hit in late 1985. Although revenue continued to grow at a brisk 30% pace, expenditures for staffing and research and development were based on projections of much higher growth. Management was slow to rein in spending, and in fiscal 1986 the company reported a net loss of $1.7 million on sales of $43.6 million. Its stock fell to $4 per share. In late 1986, Pyramid's board of directors hired Richard Lussier as chairman, chief executive and president, replacing chief executive E. David Crockett. Lussier had served for three years as chief executive of computer equipment manufacturer Verticom Inc., and earlier was executive vice president at peripherals vendor Masstor Systems Corp.

Today, Lussier agrees that Pyramid lacked market focus in the days before he came on board and that management had not acted quickly enough when growth slowed. But he dismisses criticism that the company was trying to become a major supplier of general purpose computers and compete with IBM, Digital Equipment Corp. and others.

"There were no bad decisions; there was a lack of decisions," Lussier says. "This was actually a much more solid company than the picture that had been painted."

Shortly after becoming Pyramid's point man, Lussier concluded that the company's departmental operations — particularly sales — were operating too independently and without overall direction. "That's a dangerous way to manage," he says. Marketing was directed to work more closely with sales, research and development and other operations, and to play a stronger role in setting the company's direction.

To oversee that effort and strengthen the company's marketing operations, Lussier named Edward W. Scott Jr., then director of Sun Microsystems Inc.'s federal division, as marketing vice president.

Lussier also determined that Pyramid's sales organization was spread too thinly across too many markets. Sales efforts were revamped to concentrate on four markets: telecommunications, applications development, financial services and government.

Lussier describes his strategy for building Pyramid as "pay as you go"

Today, telecommunications accounts for 55% of Pyramid's U.S. sales, with the balance equally split between the other areas. From the first quarter of fiscal 1988 to the first quarter of fiscal 1989 alone, revenue per salesperson skyrocketed from $1.1 million to $2.4 million.

Moving to bring R&D expenses under control, Lussier ruled that only such giants as IBM and DEC can afford the luxury of "confrontational project development" and canceled one of two competing development projects. "Sometimes you just have to tell people 'no,' on things like R&D," he says.

"While some people prefer to throw all caution to the wind and grow for growth's sake — and some companies like Sun have pulled it off quite successfully — that's not my nature," he continues. Using the project development decision as an example, Lussier describes his strategy for building Pyramid as "pay as you go."

That becomes clear to anyone reading Pyramid's balance sheet. The company has no long-term debt and a $20 million cash reserve. "We are very, very clean," Lussier says. "We cannot be caught by any big surprises, financially."

Targeting the high end of the commercial Unix market, Pyramid has opted not to compete in the fractured low end of that arena, where AT&T's 3B line, NCR Corp.'s Tower line and others battle for market share. "We would not be interested in a mom and pop store with $1 million in revenue," Scott says, adding that the average Pyramid customer makes $2 million in purchases the first year. "We want people who want large systems."

"Dominating the market"

Although Pyramid ranks third in the U.S. among vendors of the Unix-based systems with an average selling price of $200,000 to $350,000, the company controls more than 50% of the U.S. commercial Unix market for systems in that price range, according to InfoCorp. "So we're really holding our own, really dominating the market we're in," Scott says.

Lussier says that Pyramid's competition comes from other vendors of high-end Unix systems, such as Sequent Computer Systems Inc.'s Symmetry and Balance lines, Hewlett-Packard Co.'s Spectrum line, and Computer Console Inc.'s Power series.

Sequent also targets the government and applications sectors, while Pyramid most often sees CCI in the telecommunications market. But while the product positioning and distribution strategies of Sequent and

CCI are not vastly different from Pyramid's. "the Unix market is extremely large and Pyramid sees them in less than half of its competitive situations," concludes a 1988 Montgomery Securities report.

But with both DEC and IBM exhibiting a born-again zeal over Unix, Pyramid will likely find itself competing more often with those and other heavyweights. "There are a lot of big boys who have decided that this is an important market," Scott acknowledges. However, Scott says Pyramid computers are bought by DEC and IBM customers to use as servers within existing networks.

Pyramid's installed base now exceeds 1,600 systems worldwide, and its customers include Hughes Aircraft Co., Metropolitan Life Insurance Co., TRW Inc., the regional Bell operating companies and the Electronic Data Systems division of General Motors Corp.

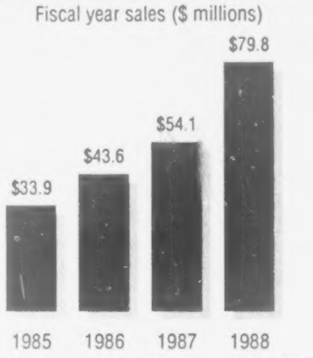
A common theme pervades among Pyramid's customers: Many decided long ago to abandon proprietary systems in favor of Unix. And after evaluating platforms from a number of vendors, they settled on Pyramid.

"We could go out and run the same identical software on all the platforms and get our own benchmarks," says Robert Handel, executive director at the New York City law firm of Davis Polk and Wardwell. "And Pyramid was clearly far ahead of DEC, IBM, Gould and all the others," in price/performance. One of Pyramid's earliest customers, the firm scrapped its aging DEC PDP-11s in 1983 and now owns 10 Pyramid computers.

DHL Worldwide Express Corp. began buying Pyramid computers five years ago and now has some 18 systems, according to information services vice president William Pigott. The Redwood City, Calif., shipping company, which uses the systems for package tracking, billing and office automation, spends between $2 million and $2.5 million on new Pyramid computers each year.

Several users cite Pyramid's in-house service operation as another reason for buying from the company. Pigott says Pyramid worked "hand in glove" with DHL to incorporate its computers into the shipping company's proprietary network. Twenty percent of Pyramid's workers are employed in the company's service operations, which Lussier describes as "profitable in its own right."

Pyramid's building sales



Source: Pyramid Technology Corp.

Software alliances

With database software a critical part of distributed computing, Pyramid has formed alliances with big-name database software vendors, including Informix Software Inc., Oracle Corp., Relational Technology Inc., and Sybase Inc., and markets those companies' products with its computers.

International sales account for 50% of Pyramid's revenue. The company uses direct sales in Britain and relies on OEMs and distributors to cover the rest of the globe: Tatung Corp. in Taiwan, the Hyundai Group in Korea, and Sharp Corp. in Japan, among others.

Expectations for 1989 sales range from $97 million to more than $112 million

The largest OEM to date has been Nixdorf Computer AG of West Germany, which resells Pyramid's 9000 line as the Targon 35 and also holds a 7.5% equity stake in Pyramid. In fiscal 1987 Nixdorf accounted for more than 26%, or some $14 million, of Pyramid's sales.

In early 1988, however, Nixdorf exercised an option to make the computers itself, cutting its share of Pyramid's revenue to about $10 million, or 12.5%. Analysts expect those numbers to drop further this year to about $6 million or just over 5% of the company's sales, despite expectations that Nixdorf will market Pyramid's newest generation of computers.

Nonetheless, Pyramid's growth has continued with income of $[illegible] million on sales of $54.1 million in fiscal 1987, and income of $8.7 million on sales of $79.8 million in 1988. Analysts' expectations for 1989 sales range from $97 million to more than $112 million.

Financing growth is, in fact, Pyramid's biggest challenge. The company has an unsecured $15 million line of credit with Bank of America, but Lussier hopes to avoid using debt for growth for at least a year. "That's the major challenge facing the company," he says. "Finding a way to fund things that won't pay off until tomorrow."

Company executives hint that the answer may be a corporate alliance with a major company, possibly a R&D partnership or an equity investment along the lines of last year's AT&T investment in Sun. Lussier will not say more, other than to emphasize that Pyramid is not looking to be acquired.

"Clearly they would make a very attractive partner for a large company looking to get into the commercial Unix market," says Jeffry Canin, a San Francisco-based independent analyst. Such a partnership would help resolve another problem facing Pyramid: name recognition. "There are still a lot of people out there who say, 'Pyramid who?' " says InfoCorp's Sill-Holeman.

Pyramid renewed its vows to the high end of the Unix market at UniForum by unveiling the Corporate MIServer line, offering a performance range of 50 MIPS to 140 MIPS with price tags of $600,000 to $2 million. (The line is object code-compatible with the older 9000 series, which has a performance range of 3.5 MIPS to 25 MIPS and a price range of $90,000 to $900,000).

Pyramid debuted the MIServer under the slogan "A Star is Born" — hence the Hollywood theme at the UniForum party. While Pyramid itself has been performing for some eight years, the company is only now facing the big time and taking its place in the spotlight. □

Quarter-inch drive makers move to ward off rivals

New data backup solutions such as digital audio tape have drive makers scrambling to increase capacity. At stake is their 82% share of the market

BY JOHN McCREADIE

Despite the threat of new competing backup technologies such as digital audio tape (DAT) and erasable optical storage, the quarter-inch tape drive still reigns in the data backup marketplace.

The industry — getting stronger as PC hard disk drive capacities increase — commands a 82% share of the data backup market, according to Dataquest Inc., a San Jose market research firm. Through consolidation, tape drive makers are looking for new channels to capture the business of an estimated 12 million personal computers and workstations still without data backup systems.

Tape drives already have an installed base of more than 3 million units, but "less than 15% of PC users" are using them, says industry analyst J. Michael Casey at InfoCorp in Santa Clara, Calif. Worldwide, analysts say, there are some 38 quarter-inch tape drive manufacturers supplying a projected 1.2 million units this year.

Overall, manufacturers enjoyed a robust 18% average unit growth rate in 1988, but analysts expect that to taper off this year to about 8% or 9%. In the next few years, revenue growth for the market is expected to increase modestly. Dataquest reports worldwide factory revenue will reach $564 million by 1990, up 9% from 1988 revenue of $519 million.

And 1990 will be the first year 3.5-inch form-factor drives will outsell 5.25-inch drives, by about 61,000 units, Dataquest estimates. In 1992 projected sales of 2.1 million 3.5-inch drives will far outdistance the 600,000 5.25-inch models expected to be sold then. Dataquest analyst Hinda L. Chalew says the projections mirror the hard disk drive industry by about 18 months, giving the industry the advantage of forecasting demand via disk drive sales.

"This plugs us in to what our next generation will be," says Whitney G. Lynn, senior vice president for peripheral products for Mountain Computer Inc. in Campbell, Calif.

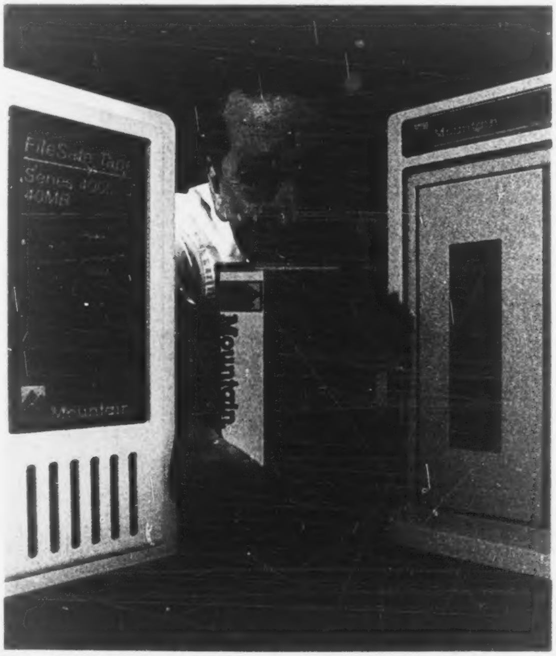
As the industry matures, some well-established quarter-inch tape drive makers, including Archive Corp. and Cipher Data Products Inc., are foregoing development of their own 3.5-inch products and instead are acquiring smaller, often retail-oriented companies. Some observers say this trend will continue as the market tightens.

San Diego-based Cipher, strong in OEM business with 1988 revenue of $185 million, acquired Ann Arbor, Michigan-based Irwin Magnetic Systems Inc. in March for $74 million. Irwin had 1988 sales of $49 million and a tidy net profit of $1.5 million. Together, the two companies have an estimated 1988 market share of 22%, according to market research company Freeman Associates Inc. of Santa Barbara, Calif.

Similarly, Archive of Costa Mesa, Calif., acquired Maynard Electronics Inc. of Casselberry, Fla., recently for an undisclosed amount, a union designed to give Archive increased retail and VAR channels.

And Mountain Computer recently announced its aggressive expansion beyond its traditional strength in distribution and reseller channels to sell to OEMs.

As of last October, Mountain closed a $45 million cash deal to be acquired by Nakamichi Corp., a Japanese company often described as the Rolls Royce in consumer stereo equipment. The acquisition, in turn, gives the tape drive maker an important strategic alliance with California Peripherals



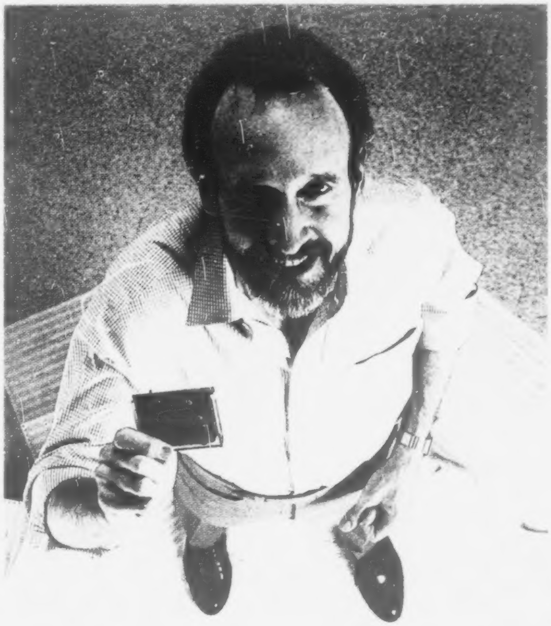
Mountain Computer's Whitney Lynn says rising projections for 3.5-inch form-factor drives "plugs us in to our next generation"

Jim Cambon

Inc. of Torrance, Calif., a $21 million OEM distributor for Nakamichi's computer peripheral products.

Early last year, CMS Enhancements Inc. of Tustin, Calif., purchased manufacturing equipment and engineering assets of the Singapore-based Data Storage Products Division of North Atlantic Industries Inc. for an undisclosed amount.

One large half-inch tape OEM sees consolidation of the quarter-inch tape industry as an attempt to stay competitive with emerging higher capacity backup solutions, such as DAT. "OEMs are moving away from quarter-inch," according to Bob N. Morris, director for product marketing for Fujitsu America Inc. in San Jose. "[Quarter-inch manufacturers] need to expand their channels to get to the end user to sell drives."



Colorado Memory Systems' William Beierwaltes: Data compression software "can double and triple our capacity"

Tim Davis

The fear of competing alternatives for tape backup and archiving continues to push manufacturers to increase product capacities rapidly and transfer rates to keep quarter-inch products attractive.

Meanwhile, the latest threat is from 20-megabyte floppy disks, expected to be seen in production quantities later this year. By 1991, market researcher James N. Porter of Disk/Trend Inc. of Mountain View, Calif., projects worldwide shipments of high-performance floppies (10MB and 20MB) to reach 750,000 units for an estimated revenue of $174 million.

But what tape drive customers seek most are lower cost and greater capacity, analysts say. Responding to those demands, quarter-inch makers have been forced to increase capacities. The strongest growth area is in 120MB and 150MB capacity drives, the newest capacity threshold, with projected 1989 shipments of 306,000 units, says Freeman Associates.

Sales of 40MB and 60MB drives still remain steady, projected to drop 19% from 1988 shipments, says Freeman Associates. By 1990 and 1991, 320MB drives are expected to be in full production with 1.3-gigabyte drives beginning to appear.

Increasing the capacities of tape drives will be aided by advances in both hardware and software data compression techniques and by improvements in the physical capacity of tape cartridges. For example, 3M Co. is now shipping limited quantities of a cartridge packed with 1,000 feet instead of the traditional 600 feet. Meanwhile, the new tape can increase drive capacity from 320MB to more than 500MB without significant cost increase.

On the software side, Colorado Memory Systems Inc. of Longmont, Colo., is offering a tape drive that uses data compression software. "We can double and triple our capacity for not very much money," notes William T. Beierwaltes, president of Colorado Memory Systems. With the software and longer length cartridges added to the company's 40MB drive, capacity jumps to about 120MB at a total cost of $600. Colorado Memory Systems' standard 150MB drive sells for $1,400.

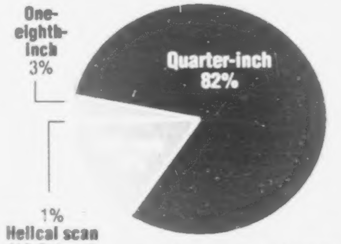
Some tape drive makers are investigating a two-chip data compression set from Stac Electronics, a small Pasadena, Calif., semiconductor company. The chips, when installed in quarter-inch tape drive controllers, can compress data two or three times. Stac president Gary W. Clow reports receiving a large number of orders from unspecified quarter-inch companies.

Meanwhile, some quarter-inch manufacturers such as Wangtek Inc. and Archive are hoping to complement their current storage lines by adding DAT products. Uncertain of the drives' potential for success, some manufacturers fear DAT mechanisms are too dependent on consumer volumes and that the technology will not move fast enough for the computing market.

Yet drive makers are keen enough to be ready if customers demand the newer, higher capacity digital tapes. "To be quite frank, it may keep us in the next potential market of tape technology," says Richard A. Peters, Archive's director for marketing.

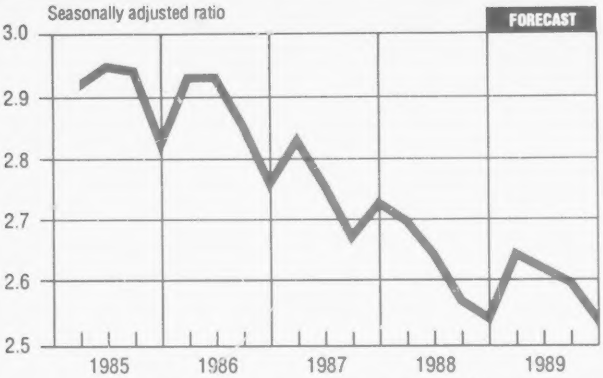
Ultimately, the quarter-inch market appears to be formidable enough to counter the threat of DAT or mega-floppies, largely because of one constant: its strong installed base. "What users want today is something a little more mundane than all the flash of digital audio tape and optical drives," according to Cipher's quarter-inch product manager Kim Kelly. ☐

1988 U.S. tape market



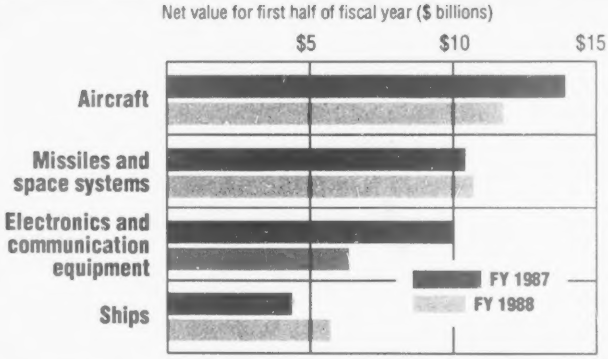
Total estimated 1988 U.S. unit shipments: 1.1 million

Source: Dataquest Inc.



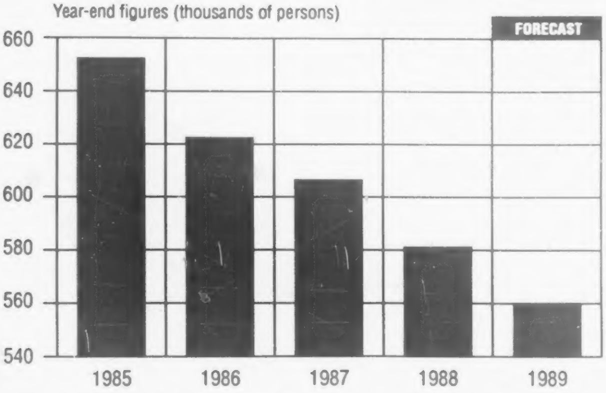
Communication equipment — inventory-to-shipments

Data source: U.S. Commerce Department; Forecast: Cahners Economics



DOD prime contract awards

Data source: U.S. Department of Defense



Communication equipment employment

Data source: U.S. Department of Labor; Forecast: Cahners Economics

Cutbacks seen on communication gear

United States-based manufacturers of communication equipment are cutting back on production. Although output of communication equipment came back 2.5% from December to January, December's production represented a precipitous decline from the month before. So, even with the one-month rise at the beginning of this year, the production index for January was the second lowest monthly level since June 1988 and was 5% below January of 1988. A squeeze in the defense sector and the general economic slowdown affecting the commercial sector mean a downward production trend through the better part of 1989.

Inventories are petering out in the defense market and rising just slowly in the commercial sector, but for the most part, management is not allowing any involuntary buildup of inventory. As of month-end January, inventory of $16 billion declined 2.5% from its year-ago level. This action has trimmed inventory-to-shipments ratios to a range of 2.4 to 2.5, down from a monthly ratio of over 3.0 at the beginning of 1986.

Equipment contracts dwindle

Cutbacks in government sector buying, particularly in the military, are having an impact on the communication equipment market. According to a Department of Defense report, DOD prime contract awards for electronics and communication equipment, not dedicated to a single weapons system, totaled $6.38 billion in the first half of fiscal year 1988, a drop of 36% compared with awards of $10.03 billion in the first half of fiscal year 1987. Even on a share basis, prime contract awards for communication equipment have dwindled. In the first half of fiscal 1987, awards for electronics and communication equipment accounted for 16.4% of total DOD procurement, while in the first six months of fiscal 1988 they represented only 11.4%.

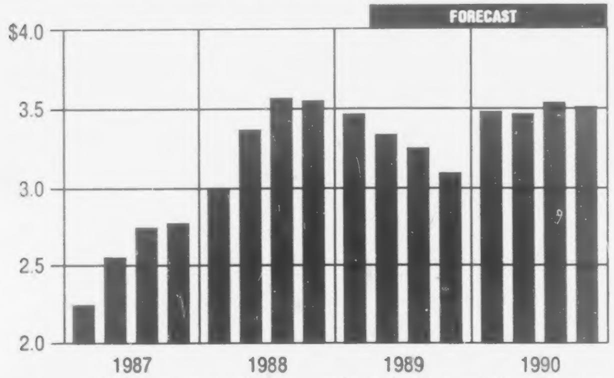
Not surprisingly, employment in the communication equipment industry has shrunk significantly. At the end of last year, the industry employed 582,200 persons, down from 652,000 persons just three years before. Employment is forecast to sink another 4%, ending 1989 at around 560,760 persons.

MADELINE FRANCHI

(Communication equipment will appear again in the August 21 issue of ELECTRONIC BUSINESS.)

Semiconductor sales slipping in 1989...

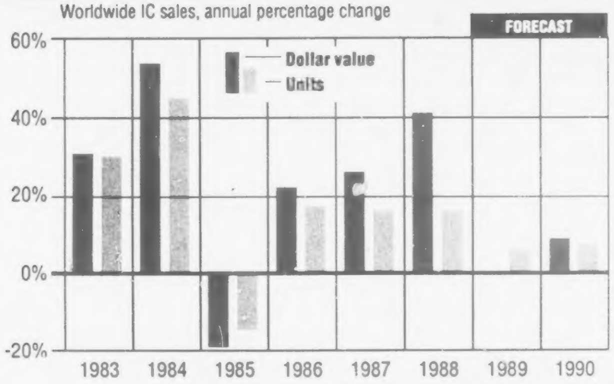
Semiconductor sales to U.S. and Canada ($ billions)



Data source: Semiconductor Industry Association; Forecast: Cahners Economics

...but unit sales are growing...

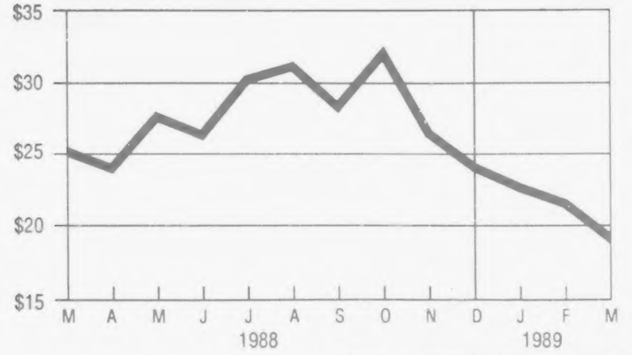
Worldwide IC sales, annual percentage change



Data source: Semiconductor Industry Association; Forecast: Cahners Economics

...because memory prices are falling

Average price for 1Mb DRAM



Data source: *Electronics Purchasing* magazine

Knowing IC prices helps in sales forecasts

As inevitably as winter follows autumn, the semiconductor industry appears poised for a slowdown in 1989. Sales of semiconductors in the United States and Canada totaled an estimated $3.4 billion in the first quarter of this year, just 15% above a year ago. While that 15% growth may seem impressive, it's down from 28% year-to-year growth in the final quarter of 1988.

Slowing growth has a lot of semiconductor companies worried about 1989 and 1990. The last time sales began slipping they ended up tumbling 30% by the end of 1985. Cahners Economics' forecast tells a different story for 1989. By the end of this year, Cahners expects U.S. sales to drop only 3% and then to rise 7% again in 1990.

Unit sales doing better

Almost all sales forecasts we talk about for the semiconductor industry are based on current dollar-valued sales. In other words, the figures are not adjusted for the inflationary effects of rising prices.

Unit sales of integrated circuits will grow in 1989 even though dollar sales are falling. That's because prices are likely to drop in 1989 after the sharp price increases of the previous year. Falling prices bring down the sales volume figures when measured in dollars, while the actual numbers of units produced and sold will be doing much better.

According to a monthly survey by our sister publication, *Electronics Purchasing*, prices for the device that created a purchaser's nightmare last year — the DRAM — fell fast earlier this year. After surging to an average $9.45 last October, prices for the 256K DRAM had dropped to $6.73 by this past March. Prices for the more advanced 1-megabit device have declined from $31.80 to $19.32 over the same period.

Prices will most likely continue to fall as new fabrication plants come on line and as yields for the 1Mb DRAM continue to improve. And as long as yields improve, falling prices are not necessarily bad for semiconductor makers.

Still, demand for semiconductors, at least in the United States, won't be growing as fast in 1989 as last year. But who says a period of stability will be so tough? Anyway, look out 1990 and 1991, because semiconductor growth will be coming on strong then.

ELIZABETH B. BAATZ

(Semiconductors will appear again in the August 21 issue of ELECTRONIC BUSINESS.)

SIX DOLLARS

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES WORLDWIDE MAY 29, 1989

BEATING THE CLOCK

U.S. firms gain by cutting development times PAGE 20

Wall Street forces a scramble for capital PAGE 37

Connector makers dig in for slower growth PAGE [illegible]

Electronic Business

FOR MANA NT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 15, NO. 11 MAY 29, 1989

PAGE 20 Codex's Jeffrey Walker and DEC's William Demmer: pros at speeding products to market

COVER STORY/STRATEGIES

20 Beating the clock: How to gain from cutting development time

Achieving faster times to market requires the coordination of every corporate division — from product development to manufacturing to marketing. But unwisely overlooked by some companies is the product development function. "Managers must realize that the product development process is not R&D," advises one expert. "It's a business process with business ramifications." Some companies are paying attention with special new product teams, decentralized management and closer links to suppliers.

COVER STORY/STRATEGIES

20 Beating the clock: How to gain from cutting development time

Getting new products to customers faster undoubtedly helps market share and extends life cycles. For many companies the answer to streamlining time-to-market may lie in product development. Some companies are scoring after restructuring their development organizations to hustle products through.

23 Digital's plan that breaks the life-cycle tyranny

Companies often are put in the uneasy position of balancing the advantages of a jump in sales with a new-generation product against the probability of lost sales because of obsolescence of an existing line. Digital's modular system design approach provides a common platform on which successive generations can be built.

25 Codex program halves development times

Codex, faced with shortening communications product life cycles, implemented a three-stage "phase review" process to streamline and coordinate product development.

26 The status of manufacturing is on the rise

Many companies still consider manufacturing to be "one of the evils" that goes with the territory. Yet that might be changing.

28 Reorganize the process, then automate

Design tools, such as CAD/CAE and CASE, automate specific steps in the development process, offering a boost to companies seeking to speed products through.

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37 Wall Street forces high tech to scramble for capital

Fast-growing U.S. electronics companies, spurned by Wall Street, are weighing "every imaginable alternative short of bank robbery" to satisfy their insatiable appetite for capital. Some CFOs increasingly are looking to overseas investors. They also are sorting out their options at home and rethinking such traditional issues as debt-versus-equity and public-versus-private financing.

51 Daring to be different in a new world of standards

In this fifth article in a series on winning with competitive engineering, McKinsey & Co.'s Ron Bohlin and Peter Mendelman discuss standardization in the computer industry. While many disagree as to what is and what is not a standard, there is agreement that standards of one kind or another are becoming increasingly influential at all levels of systems architecture.

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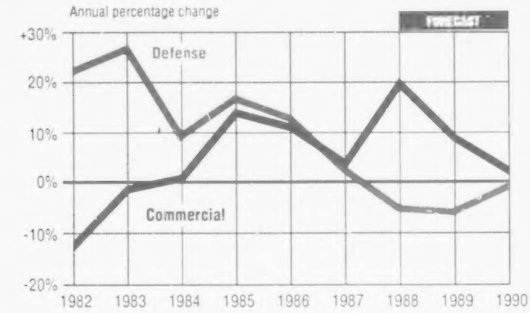
63 MITI report pats Japan's technologists on the back

Japan's research establishment thinks Japan has caught up with or surpassed the United States in most key electronics technologies. With little technology left to borrow, MITI figures it will have to start funding Japan's own basic research for the next generation of technology. The first target areas are neural computers, optical computers and high-temperature superconductors.

PAGE 85 AT&T's Bill Gilbert: "The customer won't buy a system without good network management"

PAGE 37 Sun's Austin Mayer: An initial public offering of Sun's Japanese subsidiary is a very real possibility



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73 Connector makers dig in for slower growth

American companies dominate the $14 billion worldwide connector market, even chalking up a positive world trade surplus of $2.1 billion in 1988. But there is little reason for smugness: continual attrition of vendor lists by OEMs is serving to pressure connector makers to work smarter and more efficiently.

85 Where's the beef in integrated network management systems?

The market for such INMS systems — also known as "manager of managers" or umbrella systems that can meld network managers from different vendors — is small. But vendors say the numbers are misleading as they ignore a broader demand picture. They say future communication systems sales may depend on a vendor's INMS offering.

97 Analog simulation sector will treble in four years

As digital EDA tools mature and become widely accepted, companies that have gained benefits from these devices are attempting to solve the other part of the problem: analog design and simulation. While the market for analog simulation remains small, it is growing rapidly, escalating 45% last year to $67 million.

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For manufacturers and dealers of video and audio systems, changing demographics mean a bigger and faster growing market.

124 Military electronics

The writing's on the wall. The military spending spree of the Reagan administration has given way to fiscal constraint. Still, defense news will play better for electronics, as upgrading of current weapons systems will remain a priority.

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Prepare to descend on Wall Street

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Quite a production

Reporters usually know little and care less about what happens to their scintillating prose once they hand it in. But there's a wealth of skilled effort that goes into transforming the raw copy into the refinement of a glossy magazine page.

On ELECTRONIC BUSINESS, we're lucky to have the talents of a duo that makes the conversion process look effortless: our production editor, Linda Cohen; and assistant production editor, Karen Covey.

Linda and Karen are superb traffic managers. Somehow, they know where all the copy is for any issue at any time. In fact, they're processing stories in various stages for up to three issues simultaneously.

Theirs is the unenviable pressure-cooker task of keeping things on schedule when one or two stories get off to a slow start. Processing for our production crew doesn't just mean expediting, though; they add value at many stages, be it Linda's creative assignments to photographers for our inside shots or Karen's crisp page layouts. And throughout the production stages, theirs are some of the final calls on quality: everything from the pagination to the correct headlines and colors. If only more reporters were appreciative. . . .

Downing development time

All across the U.S. electronics industry, the topic of cycle time — the period between identification of a customer's need and satisfaction of that need — has been moving up on management's agenda. Much has been made of manufacturing throughput, of JIT and EDI and zero inventory. But less has been said about the benefits of trimming the time it takes to develop a product. In our cover story, contributing editor Dwight Davis lays out a convincing case for why it's essential to be first to get the product off the drawing board.

JOHN KERR, editor

Karen Covey, assistant production editor, and Linda Cohen, production editor

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BPA ABP

Beating the clock

BY DWIGHT B. DAVIS

Profits. Market share. Margins. Return on investment. Quality. These business variables that electronics and computer manufacturers continually strive to heighten may all come down to a single denominator: time.

Sure, getting new products to customers faster helps market share. But product development is the area that can be streamlined most. Companies that realize this are scoring by restructuring their organizations to hustle products through

Reducing the time from each product's concept to its market delivery is intricately tied to a company's success and is gradually gaining among corporate priorities. The first company to market with any new-generation product inevitably will end up with the greatest market share, the greatest overall profits, and the longest product life cycle.

Achieving faster times to market requires the involvement and coordination of every corporate division — from product development to manufacturing to marketing to order fulfillment. Of these functions, product development represents the area that has received the least corporate attention to date. As such, it offers the greatest potential for streamlining and time reduction. Explains one project management expert: "Management must realize that the product development process is not R&D — it's a business process with business ramifications."

"There has been very little corporate investment in improving the product development process," says Mike McGrath, managing director of the eastern United States and Europe at consultant Pittiglio Rabin Todd & McGrath, Weston, Mass. Russell Fradin, a principal with consultant McKinsey & Co., agrees, noting, "Management invariably underestimates the costs of being late to market."

Dave Bradley

But the managers who don't underestimate lateness are overhauling their organizations to slash development times. Among the changes are: special new product teams; decentralized management; and closer links to suppliers.

The DRAM semiconductor sector illustrates advantages of being first to market, where each generation of product has seen a different dominant manufacturer, says Jack Beedle, president of In-Stat, a Scottsdale, Ariz., semiconductor market research firm. "Hitachi led the 64K market, NEC the 256K, Toshiba the 1-megabit, and Mitsubishi is the likely winner in the emerging 4-megabit market," he says, "each because they were the first company out with product."

Setting the initial price

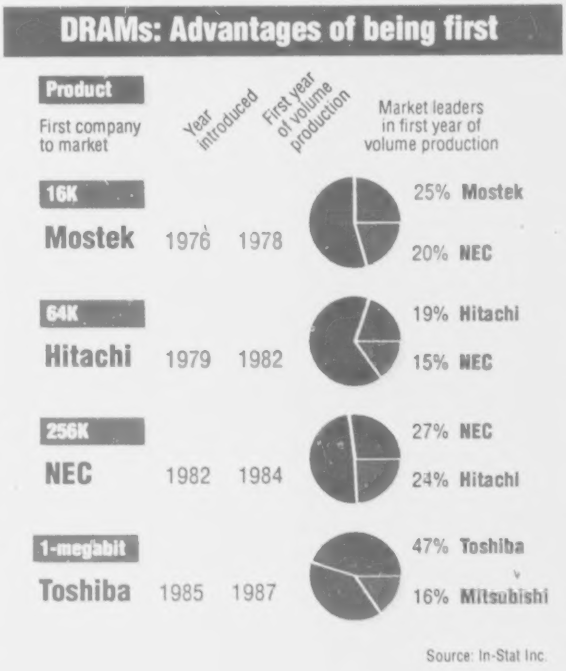
In addition, being first out gives a company greater flexibility in setting the product's initial price, thereby boosting early margins above those that follow-on competitors will realize. This was the case in the market for V.32 modems, introduced by Codex Corp. of Canton, Mass., at an initial price of about $3,500, according to Jeffrey Walker, Codex director of marketing. "The price has now dropped to $1,300 [to] $1,400," he says, "but we were able to get the higher profits early."

Even when increased market competition forces prices down, the first out retains the less-apparent advantage of maintaining its margins by way of its ability to cut production costs through a relatively high volume of manufacturing. "Product prices decline over time, but the costs of producing the products drop as the volume increases," points out Bill Miller, president and CEO of hard disk manufacturer Imprimis Technology Inc., Minnetonka, Minn.

Just as companies can increase their income on the backside of a rapid development process, the shorter process allows them to realize savings on development costs themselves. “This occurs since most high-technology development efforts require a certain ‘run rate’ of resources,” McGrath explains, “and a reduction of delays or increase in accomplishments will shorten development time and reduce the investment required.”

The development cost savings are generally not proportional to the reduction in time, McGrath says, but can still be substantial. For example, he estimates, a 45% reduction in development time would mean a typical cost savings of about 25% to 30%. As an added benefit, a somewhat surprising consequence of reduced development times is product quality. “Shorter cycle times demand more emphasis on doing things right the first time,” McGrath says, “because you can't afford mistakes further down the line.”

DRAMs: Advantages of being first



Source: In-Stat Inc.

Shrinking life cycles

Many companies, despite the clear benefits, have been forced to address the issue of compressing product development because of changing market and technological factors. Foremost among these is the shrinking of product life cycles in virtually every electronics industry sector.

The life cycle for personal computers, for example, has dropped from three to four years over the past few years to about two to three years today, “and it's getting shorter,” says Paul Lam, senior consultant in the Electronic Systems Section of consultant Arthur D. Little Inc. of Cambridge, Mass. In the semiconductor industry, meanwhile, life cycles have fallen from four to five years to about three years, he says. In-Stat's Beedle cites even shorter semiconductor life cycles of from a year and a half to two years.

The highly competitive market for workstations is also struggling with shortened product lives, says Mike Schafir, product manager in the workstation division of Sun Microsystems Inc. of Mountain View, Calif. “Competitive companies in this business need new products at least every two years,” he says.

Laptop computers in recent years perhaps have shown the most extreme example of short-lived products, having been replaced approximately every 18 months, according to Tom Martin, vice president of the computer business unit at NEC Home Electronics (U.S.A.). “The life cycle might have dropped to as low as 12 months if it weren't for the inability of the reseller channels to absorb that great of a rate of change,” he says.

Now, Martin says, laptops may begin to buck the shrinking life cycle trend because many of the desired features — such as hard disk storage up to 100 megabytes and high-contrast screens — have been provided by the earlier generations. Even if the high turnover moderates, however, the incentive to expedite the development process will remain strong, he says, in order to realize the benefits of being first to market.

The incentive to be first out is especially powerful in industry sectors such as the OEM disk drive and semiconductor markets. In these, the “window of opportunity” for manufacturers to lock in customers has been shrinking dramatically. Even if product life cycles are fairly stable — as they have been in hard disk drives — this closing sales window is forcing faster new product development cycles.

“If you were not first to market in years past, there was no great harm done, because your customers would take a year or two to evaluate new products before signing volume contracts,” explains Miller at Imprimis. “Now there is less than a one-year period in which all the major OEM contracts are settled.”

This speed-up has occurred especially with OEMS that sell products with short life cycles such as PCs or workstations, he says. Because their systems' lives are so short, the OEMs evaluate components like disk drives quickly and want volume shipments sooner.

“Before, we would ship a few evaluation units and there would be no volume demand for nine to 12 months,” Miller says. “Today, some OEMs want thousands of units within three to six months of the first shipments.”

The common, underlying force pressing manufacturers to shorten product life cycles is that of accelerating technological change — particularly in semiconductor technology, which, in turn, stimulates constant change in products based on microchips. “Historically, the inherent rate of change of semiconductors — as measured by circuit density — has been in the 30% to 40% range” annually, says William R. Demmer, vice president of Digital Equipment Corp.'s midrange systems business group, Boxborough, Mass. “The current rate is close to double that.”

Demmer points to the time required to move from discrete to integrated implementations of the CPUs in VAX computer systems as evidence of this trend. “Following the

Digital's plan that breaks the life-cycle tyranny

Beating competitors to market undoubtedly is a good strategy, but one some manufacturers consciously choose to avoid. A company's new generation product often will cause the obsolescence of its existing line, leaving a manufacturer balancing the advantages of a jump on the competition against the probability of lost sales in its own backyard.

But if a firm tries to milk its investment in any product line for too long, it may sacrifice future market share. The result has many companies ambivalent about playing the faster-time-to-market game.

Customers, likewise, have reservations about extremely rapid product turnover. While the market overall may eagerly anticipate the next technological innovations, individual customers don't want to find that the electronics equipment that they bought a year or two earlier is antiquated today.

Breaking the cycle

To break from this cycle, some manfacturers are experimenting with new product designs that allow a less-disruptive product path evolution. Digital Equipment Corp. is pursuing such an approach with its VAX 6000 series of midrange computers.

"In the past, each new computer generation was a discrete event," explains William R. Demmer, vice president of Digital's midrange systems business group in Boxborough, Mass. "We would design one computing system, and then would design another completely separate physical system to replace the old."

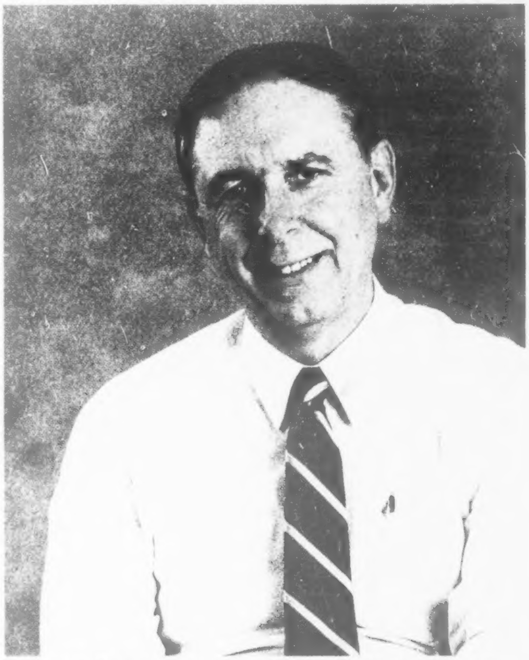
However, the VAX 6000 series comprises a modular approach to system design, with a common foundation platform upon which successive generations of machines can be built. "The basic physical platform was overdesigned for the initial product so that it can handle future evolutionary change," Demmer says.

The first VAX 6000 series machine, the VAX 6200 systems, contained from one to four processors. Using the same basic platform, the follow-on VAX 6300 — introduced nine months later in 1988 — permits up to six processors, each of which offers 35% more performance than the VAX 6200 CPUs. The maximum six-processor 6300 configuration offers twice the performance of the maximum four-processor 6200.

Similar memory structures

"Meanwhile, we've kept the same memory structure, bus structure, and software compatibility," according to Demmer. This makes it simple for 6200 customers to upgrade their machines to the 6300 level if they so desire.

Digital has encouraged such upgrades with its pricing. Despite its 35% performance advantage over the 6200 line in single-processor configurations, the 6300 is priced at just 5% above the earlier machine. As a result, "We're still marketing the 6200, but not seriously," Demmer says.



William R. Demmer, vice president for Digital's midrange systems business group: "We're preserving about 90% of our and our customers' investment in each successive product"

Dave Bradley

In future iterations, the 6000-series VAXs might provide denser memory capabilities or improve the current I/O bus structure, Demmer speculates. Only when the component evolution reaches the platform's design limitations will a new platform be introduced.

"The life of the system platform might be three to four years," Demmer predicts, "but components like processors might change every year or so."

Because the bulk of the system stays constant during the series evolution, the development of new products is both simplified and shortened. "No engineering design changes are required until we shift to a new platform."

Although the VAX 6300 essentially replaces the VAX 6200, it is possible that not all 6000-series changes will be so evolutionary. "At some point, we may choose to offer more than one product in the line simultaneously," Demmer says.

"We hope to simulate a mindset change both internally and at our customers," he continues. "Because we're preserving about 90% of our and our customers' investment in each successive product, we think we can eliminate the desire to extend the life of products such as the 6200 at the expense of slowing new product introductions."

DWIGHT B. DAVIS

1978 introduction of the first VAX, the VAX-11/780, it took five to six years to move from 'jelly-bean' type semiconductor capabilities to a microprocessor implementation of the CPU," he says.

"At the high end of our 8000-series of VAXs, by contrast, we went from a gate array, discrete logic implementation to a micro version in less than three years," Demmer adds.

A downside to rapid technological change exists: "When technology advances too rapidly there is a time lag between the capabilities of the products and users' ability to apply them," notes ADL consultant Lam. He says it's not clear if, as occurred in laptops, other markets' ability to absorb the new technologies is approaching the saturation point.

In fact, he says, there are some indications that a new-generation product may do well even if its predecessor hasn't been fully utilized. "You might think that the acceptance of the Intel 386 chip would be slow because all of the 286 chip's power has yet to be exploited. But companies are moving quickly to the 386 because it permits them to get a higher price per product."

In coping with the growing imperatives to cut product development times, manufacturers' responses cover the range of doing nothing at all to completely overhauling their development organizations. However, agreement on a key point exists among analysts and those companies working to reduce cycle times: the current processes employed must be evaluated and problems identified before any real benefits can be realized.

Automation can help, but . . .

As a result, these analysts and executives say, tools such as computer-aided design, project management, and computer-aided software engineering must be viewed as being of secondary importance. While such tools can significantly improve development times, "if you simply automate your current way of doing things, you may automate the wrong processes," warns PRTM's McGrath.

For manufacturers, the most common development organization — that of assigning tasks by functional responsibility — has proven to be both inefficient and slow, analysts say. Under this approach, each functional task, whether product design, market analysis, or manufacturing, is performed in relative independence.

"Problems arise with the functional orientation because of departmentalization and lack of coordination," says ADL's Lam. Tasks are done sequentially rather than in parallel, groups "sign off" from the project as soon as their job is done, and the entire process lacks cohesiveness, purpose, and accountability.

At many firms, lagging interdepartmental communication stalls manufacturing input early on in the design process. "Because of this, when new products get to manufacturing they often are either not manufacturable to cost or manufacturable at all," Lam says. Thus, many products go through numerous iterations of design and testing, he says, essentially dooming the attainment of faster development goals.

Various approaches do exist to implement more effective development organizations, including Codex's "core team" concept. The objective of these approaches is to group teams around the common activity of shepherding a product from the conceptual stages through manufacturing and distribution. "The greatest gains are achieved by coupling these functions rather than by improving each in isolation," says McKinsey's Fradin.

Simplified decision-making, put in place at Imprimis, is another common element in reorganizing development operations. "In 1985, our hard disk line was badly out of date, especially in the smaller form factors," says Imprimis' Miller. "One of the first things we did was to decentralize from the central management and reduce the length of our decision chain."

New products groups

Some companies — Digital and Sun included — have set up internal organizations devoted to handling new products all the way through pilot production. "Once our New Products Group produces the first 100 to 150 systems, we have a transfer process to move the design into volume manufacturing," says Sun's Schafir. "This way, our volume operation doesn't have to become overly concerned about design issues."

At Digital, a 2-year-old Product Business Unit approach provides a tight coupling among engineering, manufacturing, and marketing activities. It also includes a New Product Start-up function, like Sun's, that moves products through the pilot production stage. Digital's Demmer credits the impressive volume sales of the VAX 6000 series — the fastest selling VAX ever — to the new product operation.

"We were able to prepare geographically dispersed manufacturing

What some other companies are doing to cut their product development times

Sun Microsystems Inc.

Product: Workstations

Action: Set up a new products group to transfer design into volume manufacturing after 100 to 150 systems are produced.

"This way, our volume operation doesn't have to become overly concerned about design issues"

— Mike Schafir, product marketing manager, workstation division

Imprimis Technology Inc.

Product: Hard disk drives

Action: Shortened decision-making process in reorganizing development operations.

"One of first things we did was to decentralize from the central management and reduce the length of our decision chain"

— Bill Miller, president

NEC Home Electronics (U.S.A.)

Product: Laptop computers

Action: Moved its technology center from Japan to San Jose to improve communications with suppliers.

"Improving our physical proximity to our suppliers far outweighed the benefits we could have realized through electronic solutions"

— Tom Martin, vice president for marketing and development

Codex program halves development times

Codex Corp. of Canton, Mass., watched during this decade as the life cycles of its communications products dipped from five to six years to two and a half to three years. At the same time, the Motorola Inc. subsidiary was targeted more and more by the competitive gun of the Japanese — especially in the commodity-like markets for its low-end modems — and Codex struggled to keep pace with rapidly advancing communications technologies at the high end of its multiplexer and network management lines.

Finally, in late 1987, the combination of these factors drove the company to initiate a trial program designed to halve the time required to bring new products to market, says Jeffrey Walker, Codex director of marketing. A year later, the trial program had largely met this goal in three demonstration projects and, this year, it was implemented company wide.

Codex called on the consulting firm of Pittiglio Rabin Todd & McGrath of Weston, Mass., which resulted in the formation of a PACE (Product and Cycle-Time Excellence) team to accomplish necessary organizational changes.

These changes fell into three main categories, according to Mike McGrath, PRTM's managing director of the eastern United States and Europe, the PACE team leader. A "phase review" process was implemented; product development personnel were grouped into core teams, each having a single project manager; and the development process itself was simplified, standardized, and documented. A key goal of the three-stage phase review process was to define the authority and responsibility of both an executive-level Product Approval Committee and the core team itself.

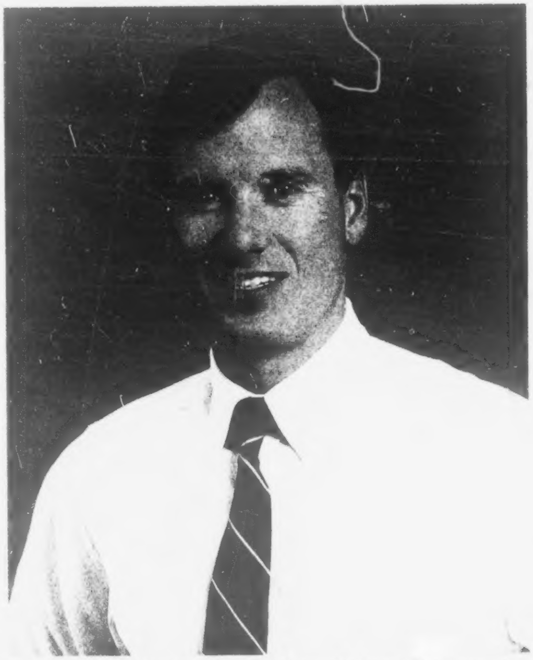
"We needed to eliminate a lot of the unnecessary bureaucratic reviews that are common to all companies," says Walker. McGrath notes that, with the phase review restructuring, "95% of the decision-making authority resides with the core group, and 5% with management in its approval making role."

Evaluation of all functions

The first of the phase reviews occurs after the product specifications and development schedule have been determined. "The major phase review one document is the Summary Product Implementation Plan, which includes everything from the hardware design, to the manufacturing, marketing, and quality requirements," explains Paul Phelan, senior director, total cycle time program.

The second review occurs at the time of the first customer shipment and the start of volume manufacturing. The final phase review follows three to six months later, and evaluates the product's adherence to its schedule and specifications.

Performing the various phase reviews is the product's core team, consisting of a program manager and personnel from all the major functional areas such as marketing, manufacturing, quality assurance, and customer service.



Dave Bradley

Jeffrey Walker, Codex director of marketing: "Because of our more efficient use of development resources it will be easier for us to respond to a wider range of market opportunities and to realize a higher percentage of 'wins' "

"The teaming concept has resulted in better communications and coordination between the different departments," says Phelan, "and accountability is now centralized with the program manager." Along with speeding product development, another expected benefit is higher quality products.

The early results of the PACE-driven changes show reductions of development times from 43% to 50%, with the more complex products realizing slightly greater improvements than simpler ones. Based on composite results achieved so far, the development time for a product of moderate complexity has gone from 145 weeks to 67 weeks, according to Phelan. Such a product would be new to market, as opposed to being an upgrade of an existing device, but would not require any new VLSI development, he says.

Streamlining and coordinating the development process will have benefits beyond shorter times to market, Walker says. "Because of our more efficient use of development resources," he says, "it will be easier for us to respond to a wider range of market opportunities and to realize a higher percentage of 'wins' with our products."

DWIGHT B. DAVIS

Why U.S. firms have to reduce product development time...

- Product life cycles are shrinking
- Development costs are increasing
- Technology is changing rapidly
- Customers are evaluating new products more quickly

...and how are they doing it

- Evaluation of development process
- Tightly coupled new products groups
- Streamlined product designs
- Improved communications with suppliers
- Greater use of design automation tools

facilities to follow a rapid volume ramp up," he says. "On the day [April 1988] we announced the VAX 6200, we began shipping units from our plants in the U.S., Puerto Rico, and Ireland." This volume manufacturing capability put Digital in the happy position of never being supply limited — a familiar problem with earlier lines. When the follow-on VAX 6300 was introduced nine months later, Digital had already done business into the $2 billion range with the 6000 series.

Besides reorganizing and exploiting the power of automation tools to shorten development times, manufacturers also are rethinking the fundamental designs of their products. In semiconductors, for example, "Companies are using ASICs or standard cells to get into the market first," says Zohar Raz, vice president of technology at In-Stat. "Once they've captured market share, they redesign the product to reduce the silicon count."

Another semiconductor design trend is that of reduced instruction set computing (RISC), as opposed to complex instruction set computing (CISC). "Sun developed its RISC-based Sparc architecture for its workstations in part because it is easier to implement than CISC, and helps us get chips faster and debug them sooner," explains Schafir.

Beyond semiconductors, many companies are devoting more attention to determining which product features are critical and which are extraneous. "Nothing will kill a new product faster than putting every bell and whistle on it," says Walker at Codex.

EDI: The link to suppliers

A final area of investigation is electronic data interchange, or EDI. Just as companies must improve their internal lines of communications to speed product development, they also must bolster their links with suppliers to ensure timely component deliveries, and with customers to better gauge and satisfy market demand.

But EDI remains little more than a distant goal for most manufacturers, although "within the *Fortune* 500 companies EDI is being evaluated ag-

The status of long-slighted manufacturing is on the rise

Manufacturing clearly plays a critical role in the drive to place products in customers' hands sooner. Yet, despite the preachings about factory automation, computer-aided manufacturing, and just-in-time processing, most companies still consider manufacturing to be "one of the evils" that goes with the territory, says Anthony Friscia, president of Advanced Manufacturing Research.

"Especially in small electronics industry companies," he says, "manufacturing is the last thing people think about. It is viewed as a cost center, and generally receives management attention only when problems occur."

But fortunately this attitude is no longer universal, and some firms even view manufacturing as the main area to improve time-to-market speeds. "We have already dramatically improved our product development operation," says Bill Miller, president of Imprimis Technology Inc., "and we believe that increasing our production ramp-up capabilities represents the area of the greatest potential gains."

Imprimis is pursuing a multi-track approach, Miller says, with the goal of designing products to match production processes.

For example, if manufacturing engineers don't have a say about a product's design early on in the development process, they may later be asked to produce a product poorly suited to their production facilities.

Improving the materials-handling process can cut idle time

The need for better internal, as well as external, communications is heightened if a firm attempts to implement a JIT operation, in which inventories of components as well as finished products are reduced or eliminated. Components arriving from suppliers are immediately sent to production lines, and completed products are immediately packaged and shipped.

"JIT involves coordination of a network of suppliers and a tighter linking between the manufacturer and its customers," Friscia notes.

Even without JIT, companies can make great strides toward streamlining their manufacturing processes through relatively simple means, Friscia believes. "On average, raw materials sit around for more than 90% of the time without undergoing any active processing," he notes. By re-laying out a plant and improving the material handling processes, much of this inactivity can be eliminated.

Friscia cautions that manufacturing speed by itself isn't enough of a solution, advising that U.S. firms emulate the Japanese attitude of placing manufacturing on somewhat of a pedestal. "Philosophically, U.S. firms should be building their businesses around their ability to produce quality products," he says. "But most companies here are still more technology driven than manufacturing driven." □

gressively," according to Anthony Friscia, president of Advanced Manufacturing Research. He says some companies such as General Motors Corp., Ford Motor Co. and Boeing Co. are severely limiting the number of suppliers with which they do business, and are then working to establish EDI links among those that remain.

NEC Home Electronics took a different path in improving its communication with suppliers. It shifted its technology center 8,000 miles from Japan to San Jose in order to be closer to the core technologies its laptops use. "Improving our physical proximity to our suppliers far outweighed the benefits we could have realized through electronic solutions," Martin says.

For those companies that succeed in compressing their product development cycle, one remaining benefit exists, according to PRTM's McGrath. "If you have a one-year rather than a two-year cycle, you can better predict the market's needs at the time your product appears," he says.

If the development process takes too long, McGrath continues, the target market's demands may change. "Products that take a long time to reach the market are therefore more susceptible to redesign during the development cycle." And some companies with fast development turnarounds get the luxury of delaying the start of the process, if they so choose. This option, though, is a dangerous one, argues McKinsey's Fradin.

"Often, the issue is less one of how to speed development time than one of how to heighten the organization's ability to start a project early when the opportunity is greatest," he says. "In most cases where market share is lost it is because the company was late in starting its development."

Fradin has dubbed this scenario the "organization paradox." In it — at the time when the opportunity is greatest and before any signs of competition exist — the company's sense of urgency is the lowest, he says.

Therefore, the effort to shorten product development times is linked to beginning as early as possible. "Once the first competitive products appear on the market, the sense of urgency to develop like products is greatest," Fradin says. "Of course, by that time, the opportunity for success has largely passed." ☐

Reorganize the process, then automate

Although industrial consultants have their differences about how to best achieve faster product development cycles, they all agree on one key point. As stated by Russell Fradin, a principal at McKinsey & Co.: "Mechanical tools to effect faster turnaround times should be applied only after the process itself is revamped."

Companies must first gain an understanding of their institutionalized delays and inefficiencies and move to correct them, Fradin says, otherwise they may be ill prepared for the power of tools such as computer-aided design, project management, and computer-aided engineering. "You don't give a 5-year-old a Ferrari," he cautions.

Automation can boost firms seeking faster development times

That caveat aside, automation tools can give a big boost to companies looking to speed product development. "With the simulation techniques of CAD/CAE, we can model everything from the gate level of semiconductors all the way through the system component level," says William R. Demmer, vice president of the midrange systems business group at Digital Equipment Corp.

Like CAD/CAE, computer-aided software engineering, or CASE, automates specific steps of the development process. CASE is particularly useful, claims Al Connor, vice president of industry marketing at CASE vendor Nastec Corp., because of characteristics peculiar to the software development culture.

"Most software developers didn't start as engineers, and they lack the well defined methodologies of design engineers," he explains. "Software engineering is more of an art form."

The problem with art forms is they are difficult to describe and schedule. "CASE tools provide a standard breakdown and description of the development tasks and give companies a set of guidelines to follow in tracking the work's progress," Connor says.

Some firms see productivity gains as great as 30%, according to Connor, who notes CASE can be cost effective at much lower levels of improvement: "American Express estimates that a productivity gain of just 5% is enough to justify the purchase of CASE tools."

CASE can be especially useful at the front end of the development process, when the manufacturer's software people get together with users to define a product's requirements, says Connor.

If any automation tool has the capacity to closely mirror and assist the overall development process, it is that of project management software. Even vendors of such software caution, however, that it is best to mold the project management product to suit a company's proven process.

"Project management is not intended to solve your development problems," says J. Kevin Fisher, president of project management vendor Productivity Solutions Inc. of Waltham, Mass. "Rather, it helps managers define project goals and use resources in the most efficient means possible."

Fisher notes that in the technology development area, time and resources must be put into balance. However, he notes, many companies simply initiate projects and "hope that things will get done through some serendipitous process. Management has abdicated its responsibility to evaluate and monitor that process."

Project management software can help companies assert tighter process control. It is especially useful when limited resources must be allocated among multiple development projects. "If used properly, project management can help managers understand that the development process can be used as a competitive weapon," Fisher concludes. ☐

Connector makers dig in for slower growth

The worldwide connector business will grow 5.6% annually through 1993. That likely isn't enough to sustain all of today's players

BY TONY GREENE

Some American companies have come to accept the fact that their days of global dominance in any area are numbered. They've watched as Japan, other Asian countries and Europe have become more effective competitors in the world market.

But there is one electronics sector where this is not even remotely true. The worldwide connector industry is dominated, and looks likely to remain dominated, by U.S. manufacturers. Six of the top 10 worldwide are American. Of the remainder, three are Japanese and one is European. Indeed, U.S. connector manufacturers chalked up a positive world trade surplus of $2.1 billion in 1988, according to connector market research firm Fleck Telesis Inc., of Huntington Beach, Calif.

There is, however, little reason for smugness on the part of U.S. connector vendors. Continual attrition of vendor lists by original equipment manufacturers keeps pressuring connector makers to work smarter and better. Global equipment and materials sourcing is more of an issue than ever. Partnerships with distributors become more crucial. And the push on quality does not let up.

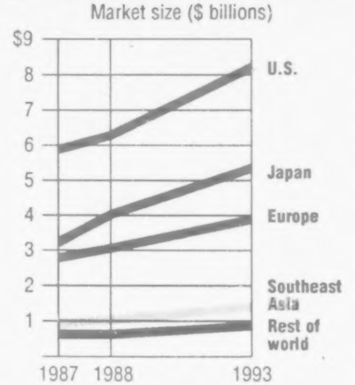
It is estimated that there are between 600 and 800 manufacturers of interconnect devices (connectors, backplanes and cable assemblies) worldwide, competing for a global market of $14 billion; that's up 11.7% over last year. Many of the companies, though, are truly small fry. Eighty-three percent of the market is accounted for by the top 375 companies and over 400 companies have sales revenue of less than $1 million, according to Fleck Telesis. The world market is expected to grow 5.6% annually to reach $18.27 billion by 1993.

Although the market is currently shared by many, the future may hold spots for a substantially smaller number. Connector makers and industry watchers alike see a continuing shakeout in the industry. "I believe there's room for just four or five [major] connector suppliers. A good recession would help us," quips one vendor.

Shakeout is being encouraged by customers that are whittling down their vendor bases as they seek longer term relationships with a few large, financially stable suppliers that can offer the broadest product lines. "When those OEMs come in, they care as much about your financials as they do about your product package," remarks Dominic Pileggi, president of the electronics division of Thomas & Betts Corp., the large Bridgewater, New Jersey-based connector maker.

Another major issue for interconnect makers is technology. "The fact of the matter is, the technology explosion has finally begun to have an impact on interconnection to a substantial degree. For many years, connectors have been static in relation to the electronics revolution. Some companies are in production of connectors that are four generations old," says Kenneth Fleck, president of Fleck Telesis.

Worldwide connector market by region



Source: Fleck Telesis Inc.

New product contributions

That may be changing fast. At No. 2-ranked Amphenol Corp., Wallingford, Conn., president Martin Loeffler cites new product contributions to sales revenue rising from 7% last year to 10% in 1989.

In addition to new connectors, customers also want more interconnect systems. The days of selling connectors and only connectors are fast disappearing. Creating new product is expensive and the financial burden involved will help accelerate the consolidation of the industry.

Possibly the most pervasive issue that will fuel the continuing shakeout is the global nature of the connector industry. Amp Inc., the Harrisburg, Pennsylvania-based industry leader that had $1.87 billion in sales in 1988, has nearly 160 facilities in 26 countries. "The global outlook is the only long-term outlook to be a successful company. We are fully focused on maintaining 15% growth in the future. To do that we have to be a world class global producer," says Amp's president James Marley.

The U.S. market, with $6.152 billion in noncaptive connector sales in 1988, while the largest world market, still comprises only 44% of worldwide sales. Japan, with $3.852 billion, and Europe, with $3.045 billion, combine to account for 48% of the global business. Japan was also the fastest growing world market for connectors, growing 26.7% in 1988 over 1987 sales of $3.042 billion; it is expected to reach $5.13 billion by 1993. "The global nature of the business is critical for those [companies] servicing the 20 to 25 top customers in the world. The top 25 customers make things happen technologically," says Jerry Labowitz, a vice president with Merrill Lynch Capital Markets in New York City.

Serving the customer

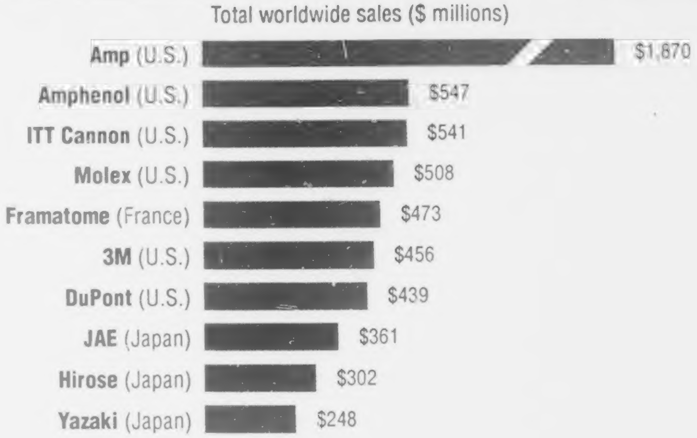
The customer is the key to the entire connector industry. When original equipment manufacturers moved offshore, their connector suppliers followed. The competitive nature of the business and the customers' desire to have their vendors where the manufacturing is mandate that connector suppliers be globe-trotters. "You absolutely must be able to service the customers where they live. Our objective is to see all our growth be international," says Marcel P. Joseph, chairman and chief executive officer of Augat Inc., of Mansfield, Mass. "If you don't manufacture you need engineering, sales and warehousing where your customers are," says Labowitz.

There were 22 mergers and acquisitions in the connector industry in 1987 and 27 in 1988

Customers are also driving connector manufacturers to give them more than just a connector. "They don't want to buy just a connector anymore; they want a cable assembly. The trend is toward higher value-added products — subsystems. They want a fuller service product," says Michael Emery, director of the interconnect and packaging group for E.I. du Pont de Nemours & Co., headquartered in Wilmington, Del.

In addition, the technology that is being interconnected is driving connector makers. "Connectors are becoming denser. There are more interconnects and more electrical performance problems. Interconnection is no longer just a mechanical problem. It is also an electrical problem," says market analyst Stephen J. Balog of Shearson Lehman Hutton Inc. This, coupled with the need for subsystems and ever decreasing product life cycles, is driving every major competitor to include an aggressive plan for product development into its strategy.

1988 top worldwide connector makers



Worldwide sales by region* ($ millions)	U.S.	Japan	Europe	Rest of world
Amp (U.S.)	$1,068	$404	$365	$163
Amphenol (U.S.)	329	30	188	33
ITT Cannon (U.S.)	310	30	234	6
Molex (U.S.)	137	227	83	71
Framatome (France)	117	53	311	24
3M (U.S.)	276	106	87	16
DuPont (U.S.)	224	50	112	70
JAE (Japan)	8	335	6	36
Hirose (Japan)	10	283	3	17
Yazaki (Japan)	43	219	10	10

* Totals do not add due to double counting between regions

Source: Fleck Telesis Inc.

R&D spending

"Survival will depend on the ability to bring product to market quickly while delivery times go down and quality goes up," says John C. Psaltis, vice president and treasurer of Molex. The push for quality is intense: five years ago parts-per-thousand fail rates were acceptable. Today, fail rates are measured in parts per million, which helps make the quest for new products even more expensive. Amp has spent 9% or more of sales on R&D for the past 30 years; last year, its R&D spending totaled $238 million. R&D budgets that average 5% to 6% of sales are common among the industry leaders.

Much of this money is spent working directly with customers to develop specific applications. Connector manufacturers are striving to produce more proprietary parts as they broaden their product lines. "We will add 30 new connector products to our line this year and 30 more next year," says Augat's Joseph. Approximately 400 of the 694 product lines on the market are commodity products supplied by 15 to 20 manufacturers. These products are highly price-sensitive. This drives companies to try and create proprietary products whose prices erode more slowly.

Another way companies are broad-

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ening their product lines is through mergers and acquisitions. According to a Fleck Telesis report, M&As in the connector industry are occurring at a faster rate than any period since the mid-1960s. There were 22 such deals in 1987 and 27 in 1988.

Pricing pressure has been severe for connector manufacturers in the 1980s. "On a weighted average, six out of eight years in the '80s, connector prices have declined. Only two years have they [connector makers] been able to pass through a price increase. These years have also seen the costs of materials, such as copper, and labor cost rise," observes Fleck. Allan Dickson, director of marketing for Wallingford, Connecticut-based Amphenol, concurs: "Pricing pressures have been quite severe over the last three years, while cost went up. 1989 will see some upward pressure in prices, maybe 5%." Amphenol, with $547 million in sales, was No. 2 in worldwide sales in 1988.

Two industry leaders, Amp and Molex, both pursue another method of customer service that allows them to maintain a proprietary footing for their connectors. Both companies manufacture special application machinery for installing connectors that are leased to their customers. This machinery is usually leased to the customer for use with connectors manufactured by the machine's owner. "Seventy percent to 75% of our product goes through some 55,000 application machines and another 10% goes through hand tools. We have always had a systems approach," says Amp vice chairman Harold A. McInnes. □

U.S. connector vendors in 1988 sell more overseas...

- **38 U.S. firms penetrate the European connector market,** and the U.S. share of the European market reached $1.422 billion.
- **25 U.S. firms market products in Japan,** with the U.S. share of the Japanese market at $948 million.
- **59 U.S. firms distribute products in Canada,** with the U.S. share at $152 million (Canadian).
- **20 U.S. firms market in Southeast Asia,** accounting for $235 million.
- **21 U.S. firms sell in Latin America,** with total shipments amounting to $107 million.
- **The U.S. runs a favorable trade surplus** in connectors, backplanes and cable assemblies of $2.1 billion.

...than others sell into the U.S.

- **108 European firms sell into the U.S. market.** Factory shipments into the U.S. market reached $442 million.
- **38 Japanese firms market products in the U.S.** Factory shipments of Japanese firms increased to $143 million.
- **61 Southeast Asian firms sell into the U.S. market.** Total shipments were $58 million.
- **23 Canadian firms distribute products in the U.S.** Shipments from Canadian firms were $146 million.
- **7 Latin American firms sell into the U.S.,** with shipments of $9 million, while the rest of the world accounts for 11 firms selling into the U.S., and $12 million in shipments.
- **Total foreign share of the U.S. market** increased to $809 million.

Source: Fleck Telesis Inc.

Where's the beef in integrated network management systems?

Vendors have been slow to deliver on promises of INMS packages. Don't they know their future communic[illegible]ns gear sales may depend on it?

BY ANNE KNOWLES

The market is small. The technology's standards are in flux. And the vendors are many. So, who in their right mind would want to take charge of the mishmash network management market? Just AT&T, Digital Equipment Corp., Hewlett-Packard Co. and IBM, for starters.

Each vendor, in the past year, has promised to deliver integrated network management systems (INMS) that do everything from diagnose faults on users' enterprise-wide networks to keeping the networks safe from prying eyes. DEC and HP have established formal corporate programs for it and AT&T has founded an organization to promote an industry standard. IBM, in an unusual move, committed to base future products on that standard. And all are trying to recruit third-party integrators and software firms to help make INMS a reality.

The market for such systems — also known as "manager of managers" or umbrella systems which can meld network managers from different vendors — is small. According to International Data Corp., a market research firm in Framingham, Mass., INMS sales by U.S.-based vendors were $10 million last year and will grow 40% compounded annually until they reach $200 million in 1992. That's a market that third-party integrators could excel in unless the DECs and HPs get their skates on.

The numbers, say vendors, are misleading in that they ignore a broader demand picture. "People are finally realizing how important the network is," says Bill Gassman, network management marketing manager at DEC's Merrimack, N.H., facility. In turn, network management has become critical. In the future, equipment makers believe, systems sales may depend on a vendor's INMS offering. And that's where the *real* money is. "The customer won't buy a system without good network management," says Bill Gilbert, division manager of network management systems at AT&T in Bridgewater, N.J.

But suppliers of network systems and their subsystems need to be clear about what they want to get out of selling INMS. "Any company that looks at network management for revenue generation is naive," says Kathryn Korostoff, an IDC analyst. "It's for account control."

To date, each piece of equipment that makes up a network — modems, PBXs, multiplexers — has come with its own proprietary network management system designed to manage, monitor and control that equipment. Each network management system (comprising a hardware controller such as a terminal or a PC running network management software) is different from the next: man-

AT&T's network management chief Bill Gilbert: "The customer won't buy a system without good network management"

Andrew Eccles

agement of the network as a whole has been nearly impossible. At best, it has been accomplished manually.

Users' priorities

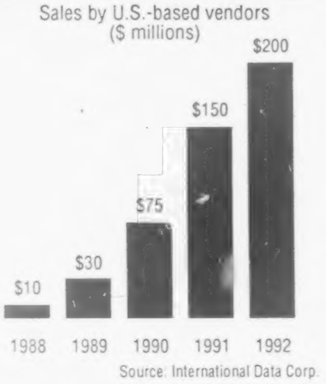
Users want more than that. According to a survey of the *Fortune* 1,000 by Network Management Perspectives, a San Jose newsletter published by CSI, a division of local area network (LAN) firm 3Com Corp., users' network management priorities are: fault detection/diagnosis, problem management/reporting tools and graphics of network status — all on a centralized network management system.

Despite the market's strategic importance, though, "equipment vendors are moving at glacial speeds," says Dixon Doll, chairman, DMW Group, a network integration consultant in Ann Arbor, Mich. Vince Barrett, a principal with Network Strategies Inc., a practice of Ernst & Whinney of Fairfax, Va., agrees: "The problem is, in spite of all the hype and hoopla from the vendors, the meaningful work is still on viewgraphs."

Part of the problem has been standards. The standards for network management — based on the International Standards Organization's (ISO) Open Systems Interconnect (OSI) model — are not completely defined. Designing products based on the early drafts of the standard means vendors will have to keep upgrading systems to remain compliant.

The OSI/Network Management Forum, founded by AT&T and seven other vendors this past summer, was formed to establish implementation specifications, says John Miller, the Forum's president and director of network management market planning at AT&T. (An implementation specification explicitly outlines how to implement a standard to achieve compatibility among products.) So far, the organization, which has grown to about 60 company members, has defined the OSI protocol stack for its users and hopes to vote this month or next on message sets for fault and configuration management, two of the five functions of network management. The other three functions are: performance management, security management and accounting management.

Integrated network management systems sales



Source: International Data Corp.

Equipment makers believe that future communications equipment sales may depend on a vendor's INMS offering

Of the four so-called umbrella vendors, AT&T is the only member of the Forum. Yet each of The Big Four — even IBM — has committed to support OSI. That's because a standard, such as OSI, is the only way network management systems from myriad vendors can be integrated under one umbrella.

It is difficult to determine exactly what resources vendors are committing to INMS. None of the umbrella vendors will discuss research and development dollars or staff dedicated to it. The systems are not cheap: AT&T's Accumaster Integrator, an INMS announced in February, costs upward of $300,000. Net/Command, an INMS systems announced by third-party Avant-Garde Computing Inc., has an average selling price of $200,000.

Users are demanding INMS packages like the umbrella solutions from AT&T, DEC, HP & IBM

But development is not trivial: Net/Command has evolved over the past two and one-half years while 11 engineers worked on it, says Mahesh Prasad, Avant-Garde's product manager for the system. Net/Command, orginally developed for an IBM microcomputer, now runs on a Sun Microsystems Inc. workstation and uses a database management system from Sybase Inc.

In the past three years, the Mt. Laurel, N.J., network management vendor has spent $10.22 million, or an average of 20% of revenue, on R&D. Excelan Inc., a LAN company recently acquired by fellow LAN vendor Novell Inc., reportedly gave up development of products based on OSI after 20 man-years of development.

IBM's move

So far, only IBM has provided users with a centralized network management scheme. Called NetView and announced in 1986, IBM's system only manages IBM networks. It is also, say observers, a repackaging of existing packages. IBM reportedly has 6,000 NetView licenses out there and about 50 third-party vendors are writing applications for IBM's NetView/PC, the company's interface into non-IBM networks.

AT&T came out with its Unified Network Management Architecture (UNMA) next and plans to ship, by year-end, its Accumaster Integrator. The Integrator allows users to window into various network management schemes through terminal emulation using a Sun workstation. Many market watchers consider it the first INMS system to reach the market. The Integrator is scheduled to ship before year-end and approximately 20 vendors are working on UNMA products to be made available simultaneously.

Both DEC and HP unveiled formal INMS corporate programs last year, called Enterprise Management Architecture (EMA) and OpenView, respectively. But neither have shipped any products based on those architectures. DEC has so far announced that seven third-party vendors are working with the computer maker to interface their network management packages to DEC's VMS-based umbrella system. But DEC cannot disclose when its system, or those of its third-party partners, will be available, says DEC's Gassman. He notes that the company has received over 200 inquiries for interface specifications, but that DEC is cautious.

"There is a lot of pressure to have

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it tomorrow," states Gassman. "But we're going to do it right. No product before its time."

HP has announced five similar third-party agreements and has promised to port its system, which currently runs on an HP Vectra personal computer under MS/DOS, to Unix. HP is currently shipping systems that manage its own equipment, says Dave Mahler, HP's product marketing manager for network management in Cupertino, Calif., but the computer maker plans to have interfaces to systems from LAN maker Ungermann-Bass Inc. and other vendors' equipment that HP cannot yet disclose.

Most of the third parties are communications equipment vendors that have substantial installed bases of existing network management systems. Modem maker Codex Corp., for example, is one of seven third parties developing interfaces for DEC's EMA. Racal-Milgo Inc. is currently working on an interface to AT&T's Accumaster Integrator that the modem maker plans to ship by the end of the year, says Bill Vasquez, Racal-Milgo's product manager for integrated newtork management systems. General DataComm Industries Inc. is currently integrating its three network management products under one system called Megaview. Then, the company will bring out an interface to IBM's NetView, AT&T's UNMA and DEC's EMA.

The U.S. INMS market will grow about 40% annually until it hits $220 million in 1992

Some third parties, such as Avant-Garde, are offering INMS on their own. Others — consultants and systems integrators such as Andersen Consulting, Boeing Computer Services Co. and Computer Sciences Corp. — are providing customized INMS services which only the largest users can afford.

But that may change once the large vendors get their act together. "Niches are difficult to defend," says NSI's Barrett. "Once the major vendors address the market, the niches may go away." ☐

Analog simulation sector will treble in four years

Affordable compute power and higher efficiencies in digital design will help drive the worldwide market to $378 million in 1993

BY TONY GREENE

As digital electronic design automation [EDA] tools mature and become widely accepted, companies that have gained the benefits of these tools are attempting to solve the other part of the problem: analog design and simulation.

Given that much of the physical world is analog, there is a real need for analog design tools and, in particular, analog simulation software. Helping meet that need are the availabilty of more powerful, affordable workstations and the rapid increase of the analog component of printed circuit boards and integrated circuits.

Although the market for analog simulation is still not large, compared with the digital simulation market, it is growing rapidly. The worldwide market escalated 45% in one year to $67 million in 1988. It is expected to grow to $103 million in 1989 and reach $377.8 million in 1993, according to the Technology Research Group, a Boston-based market research firm. "We are seeing the rapid emergence of a technology that is finally ready for the market. Analog simulation technology, up until now, has been used by only those who really needed it. What is going on is very much like what happened to digital simulation three or four years ago," says TRG's president Andrew Rappaport. With $81 million in sales revenue in 1984, the worldwide digital simulation market has since more than tripled, with sales up to a projected $290 million this year.

The major player in 1988, Analog Design Tools Inc. of Sunnyvale, Calif., had sales of $16 million in 1988. [ADT is now owned by EDA industry leader Valid Logic Systems Inc. of San Jose.] Other major players include EDA giants Daisy Systems Corp. of Mountain View, Calif., (now Daisy/Cadnetix); Mentor Graphics Corp., of Beaverton, Ore.; and microwave analog tool specialist Electronic Engineering Software Inc., based in Santa Clara, Calif. Each had sales of between $8 million and $10 million in analog simulation in 1988.

"The whole world is analog. You can pretend it is digital until you run into effects that are analog. The biggest driver for the analog market is people wanting to do larger and larger portions of their circuits analog and build larger systems," says Paul Tuinenga, executive vice president of MicroSim Corp., an Irvine, California-based vendor of analog simulation software. Because most systems have to function in the real world, almost all of them have some analog content. A report by TRG estimates that 15% of electronic designs contain at least 90% analog circuitry. This is one extreme, while at the other end of the scale, 34% of electronic designs contain 10% or less analog content. The majority of designs fall in between these two extremes, with a mix of analog and digital.

The complexity of analog simulation has kept the market technology driven. So, even though industry leaders such as Valid have been doing analog tools for more than five years, the R&D component of the business is still high. Valid's general manager for its CAE division, Curtis Hare, says the company puts a little more than 22% of analog sales into R&D and 35% of analog sales into marketing and customer support. Marketing and customer support, which have traditionally not been heavy expense areas, are becoming costlier to analog tool companies. The one industry newcomer, Beaverton, Oregon-based Analogy Inc., is planning to allocate 30% of sales to R&D and 30% to marketing.

Where analog is needed

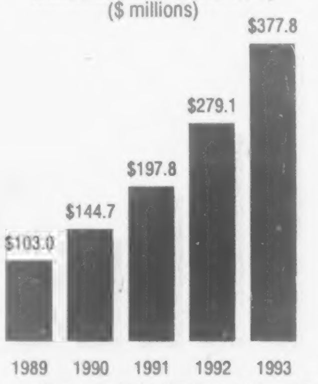
The companies that require analog simulation tools most acutely are in the military/aerospace, automotive and IC industries, according to Analogy's vice president for sales and marketing R. Douglas Johnson. In particular, the military/aerospace companies have a mandate from the government to simulate all designs in an attempt to increase reliability and quality and lower cost.

Automotive companies have seen the electronics content of cars climb steadily as electronic systems are being used in everything from windshield wipers to fuel systems and antilock braking systems.

IC designers are finding that their digital design tools do such a good job of utilizing IC real estate that they have more room for analog circuitry on chips. "Primarily, the pervasiveness of analog circuitry in electronics is driving the market," says

Analog simulation market

Worldwide sales, software only ($ millions)



Source: The Technology Research Group Inc.

David Burow, vice president for the Palo Alto, California-based analog division of Daisy/Cadnetix (Dazix).

"As things get smaller and faster you need to be concerned with analog properties. With today's digital design tools you can design systems that logically should work but physically won't work," says Johnson. The increased efficiency of digital has also decimated design time. This efficiency coupled with ever-increasing time-to-market pressure is driving the need for simulation. "The importance of analog analysis is increasing as time-to-production that used to be years, is now months. The designs are more complex," says Rappaport. This increased efficiency in digital design is making analog design a focus point for EDA companies. They are now going to be judged, by customers, on how well they handle analog.

Another major driver for the analog simulation market is the constantly improving price performance ratio of engineering workstations. "Affordable compute horsepower is driving the analog simulation market. An engineer can put a workstation on his desk and get real-time simulation," says Ron Collett, senior analyst at Dataquest Inc. in San Jose. One of the drawbacks to analog simulation in the past was the amount of memory and compute power it consumed. It was not unusual to feed analog simulation data into a mainframe computer and wait days for the results.

Modeling technology is one way analog simulation vendors are trying to differentiate themselves

"Computer science is the driving force behind analog simulation. With 8 megabytes [of memory] a digital designer can simulate anything, while with 64MB [of memory], an analog designer can only do 2%," remarks Rappaport. "Raw MIPS are important," says Valid's Hare. One MIPS cost \$20,000 in 1982, but is priced at only \$850 today, according to International Data Corp. analyst Vicki Brown.

The library issue

As the market grows and the stakes increase, companies in the analog simulation market are striving to differentiate themselves. One method they are using is modeling technology. An analog simulator is only as good as the models it is using. Accordingly, an analog simulator is only as good as its model library. "Libraries are the big issue: the more, the better. No matter how large the library, you are not going to have most of what he [the engineer] needs," says MicroSim's Tuinenga.

Even though the largest library may not have everything the engineer needs, he still wants it. All of the in-

This is how others see LCDs.

dustry leaders have libraries of at least 1,800 parts. Valid plans to have 2,500 with its next release and 3,000 by year-end. "Libraries cost the user as much as, or more than, the user interface. This is reflective of the amount of investment we have to make to the library and the importance of the library to the customer. Modeling is going to be a battle ground," according to Daisy/Cadnetix's Burow, who adds, "I kept both modeling labs open through the merger."

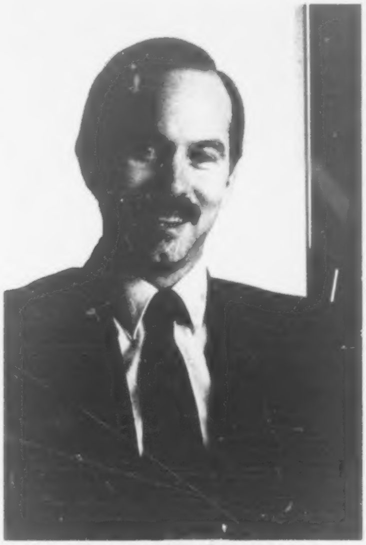
EDA market leader Mentor Graphics lets customers request the models they want. Mentor will then generate and certify the model and make it available to other customers.

The software question

The other battle in analog simulation is the fight between software packages: Sabre, Analogy's product, and Spice. Spice, the public domain analog simulation software developed at the University of California at Berkeley in the mid-1970s, is the current industry standard. The problem with Spice is that it was initially geared toward analog problems in integrated circuits. Analogy claims that Sabre can do what Spice does as well as higher level behavioral models not possible with Spice. "They're really addressing two different customer needs," says Burow. Analogy has OEM agreements for Sabre with companies such as Daisy and Valid, which use the two products for different applications. Sabre is good for looking at entire systems, while Spice excels at the chip level. Rappaport comments, "Sabre is not for the IC guy. It is for the guy doing a control system."

Future: mixed analog digital

The future of analog simulation is going to be shaped by the fact that, in five years most simulators will be mixed analog digital. Marketing agreements and strategic alliances between companies doing digital and analog simulation are appearing at an increasing rate. ☐



Analogy vice president for sales and marketing R. Douglas Johnson: Military/aerospace, IC and auto companies need analog simulation the most

Kristen Finnegan

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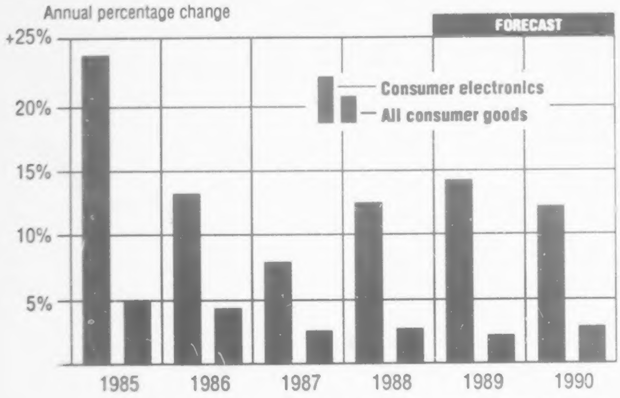
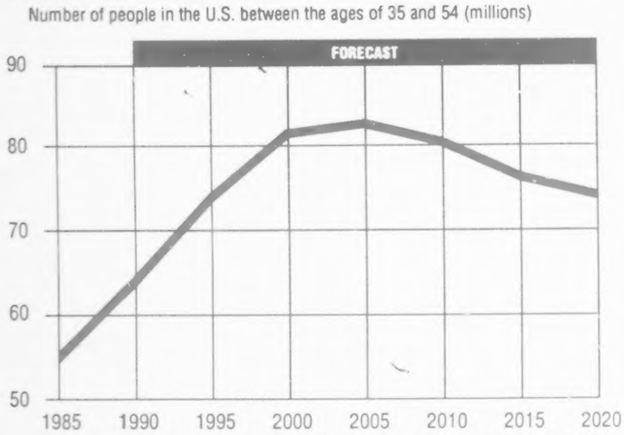
Consumer electronics outrace total spending



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Population of "peak earning year" consumers



Data and forecast source: U.S. Census Bureau

Sales of home video products

Unit sales to dealers (thousands)	Total 1988 unit sales	Annual percentage change		
		1987	1988	1989*
Color TVs	20,216	+6.2%	+4.6%	+9.4%
Color TVs with stereo	5,090	+40.0%	+17.0%	+13.0%
Black and white TVs	2,580	-9.8%	-27.7%	-28.8%
Projection TVs	302	-3.7%	+3.0%	+5.0%
Home VCRs	12,792	+1.0%	-3.9%	-2.7%

* Forecast

Data source: Electronic Industries Association; Forecast: Cahners Economics

Sales to wealthy support the consumer market

One of the best demographic trends for consumer electronics since the baby boom is in the making. For manufacturers and dealers of video and audio systems, the changing demographics mean a bigger and faster growing market. America's wealthy will be buying more expensive and more sophisticated consumer electronics products.

Over a person's work life, paychecks are fattest between the ages of 35 and 54. Those are the so-called "peak earning years" that marketers love to target. Fact: Between now and the year 2006, over 23 million more people are going to be celebrating birthdays during their peak earning years.

With all those wealthy, middle-aged consumers coming home from work, the next 15 years will be bonus years for makers of high-tech, expensive home electronics. This market of 35 to 54 year olds will be at its biggest, around 83 million people, according to the U.S. Census Bureau, just six years after the start of the next decade. And by the year 2020, over 74 million people will still be in their peak earning years.

The rich are different

For those selling the newest, most expensive, perhaps most frivolous consumer electronics, the wealthiest of the wealthy remain a critical target market. In 1987, the U.S. Census Bureau counted 5.7 million households whose income totaled $75,000 or more. It's these nearly 6 million homes where the projection TVs, future high-definition TVs and other state-of-the-art home equipment will be residing.

Who and where are America's wealthiest? Most live in or near the city. Over 90% live inside metropolitan areas and nearly two-thirds live in metro areas of more than 1 million people. Most (89%) of these wealthy households are headed by a man and most (80%) are headed by a married man. Four-fifths of them had some college experience and three-fifths completed four years or more of college.

With all these wealthy households, consumer electronics will remain a strong growth market for the electronics industry. For makers of components, these trends are not to be ignored either — the average color TV required 383 capacitors last year.

ELIZABETH BAATZ

Note: Consumer electronics is scheduled to appear again in the October 30th issue.

Military electronics firms adjust to smaller budgets

The writing's on the wall. Military electronics makers are adjusting to tighter budgets as the federal government makes clear its intention to hold interest rates down by cutting the budget deficit. The military spending spree of the Reagan administration has given way to fiscal constraint.

Defense and space equipment output fell 4.9% during the first quarter of 1989 compared with the year-ago quarter. This decline is quite in contrast with the mid-1980s when U.S. factory output of defense and space hardware routinely grew between 8% to 10% per year.

While falling output will be typical of the next few years, the industry has had a lot of time to prepare. Unlike markets where economic trends take an immediate, and often surprising toll, the defense electronics industry growth projections tend to be easily identifiable in the near term. That's because budgets, obligations and procurement take time to work their way through the system. From a forecaster's point of view, government's red tape makes accurate market projections easy.

Silver linings in a cloudy outlook

For electronics makers which have routinely supplied the military market in the past, the next few years will indeed be tough. Marginal firms will be weeded out. Still, the defense news will play better for electronics than any other supplier. Modernization and upgrading of current weapons systems will continue to remain a priority. The result: A higher electronics content will help boost demand for military electronics.

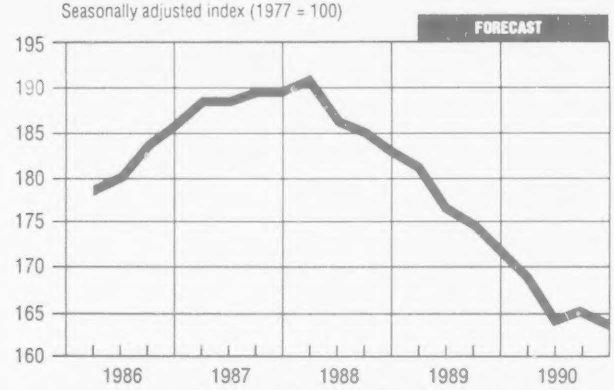
Demographic trends point in electronics' favor as well. The number of young people of recruitment age will be low over the next 10 to 15 years. With fewer soldiers available and with military readiness still a priority, defense department planning will require automation to enhance productivity.

Optimism aside, the military marketplace won't be the best growth market anymore. Take a look at shipments of aircraft. Defense aircraft shipments growth will be heading for a nose dive while commercial aircraft flies high.

ELIZABETH BAATZ

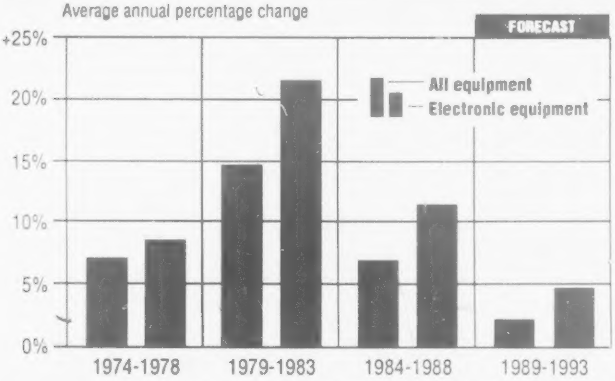
Military electronics is scheduled to appear again in the October 30th issue.

Defense & space equipment — Industrial production



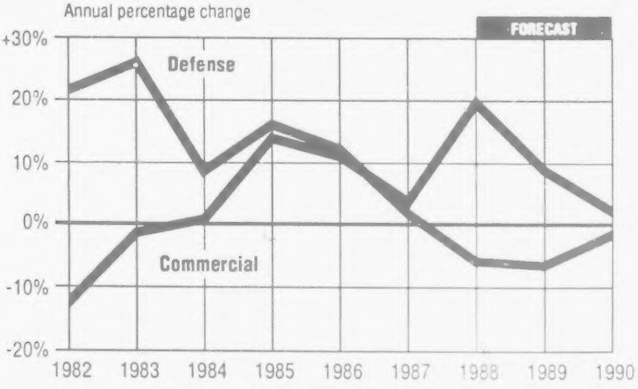
Data source: Federal Reserve Board; Forecast: Cahners Economics

National defense purchases



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Defense versus commercial aircraft shipments



Data source: U.S. Commerce Department; Forecast: Cahners Economics

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FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

JUNE 12, 1989

TOMORROW'S LEADERS

WHAT THEY SAY ABOUT YOUR COMPANY ... AND WHY YOU'D BETTER LISTEN

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TOP U.S. FIRMS POST 12% PROFIT GAINS PAGE 61

NO MORE GaAs GAFFES? PAGE 45

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 15, NO. 12 JUNE 12, 1989

PAGE 28 The best and brightest speak out

COVER STORY

28 Tomorrow's leaders: The best and brightest speak out

Innovation. Protectionism. Global competitiveness. Manufacturing's future. If these are the most pressing issues facing U.S. electronics and computer companies today, then their weight lies squarely on the talent of tomorrow's leaders — the Class of 1989. ELECTRONIC BUSINESS taps a sampling of the best and brightest minds among engineering and business school students at the country's top institutions. What they say is worth listening to.

BUSINESS TRENDS

17 Deflecting interest rates through shorter maturities

The yields are less, but investments of less than 90 days allow prudent electronics CFOs to hedge against risk when they need cash. And that trend toward fiscal conservatism isn't likely to be reversed soon.

22 Europe begins to raise the barriers to imported ICs

Higher prices and IC shortages could result following a recent ruling by the EC requiring local wafer diffusion. The action effectively pressures OEMs that use U.S. or Japan-made chips to make "Made in Europe" hardware.

COVER STORY/THE CLASS OF 1989

28 Tomorrow's leaders: The best and brightest speak out

The top engineering and business graduates from four of the nation's leading schools, MIT, Wharton, UCLA and Stanford, say what's right—and wrong—with U.S. computer and electronics industries. There are some important lessons here for you and your company.

32 Corporate cultures: First impressions count

Hotly pursued by recruiters, the Class of '89 makes snap decisions about companies as winners and losers. Students give a thumbs-up to Hewlett-Packard, Sun and Digital Equipment.

34 The workplace: What top graduates are seeking

Flexibility, opportunity and variety are more important than salary and benefits. Students want positions that will develop their professional skills, technical knowledge and reputation.

36 Manufacturing gets the cold shoulder

Graduates see manufacturing as tedious, narrow, poorly managed and lacking in challenge. One student says, "That's why the United States is slowly losing its competitive edge."

STRATEGIES

45 Spurned GaAs chip makers resort to Marketing 101

For much of this decade, gallium arsenide chip makers have earned the unwelcome reputation as purveyors of an exotic technology that few could afford and even fewer needed. But a new marketing tactic based on silicon-compatibility makes a dramatic departure from the past.

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PAGE 61 Coining it: Top U.S. firms show 12% profits gain

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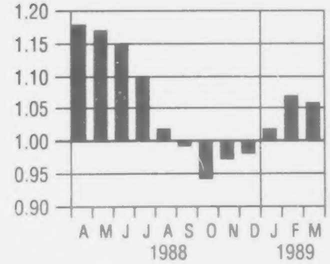
PAGE 17 HP's CFO Bob Wayman: Managing cash flow on a global scale



PAGE 89 Trade and the Leading Indicator

MANAGING RESOURCES

61 Coining it: Top U.S. firms show 12% profits gain

Paced by the high-flying semiconductor, systems and government groups, the elite of the U.S. electronics industry posted another hefty year-to-year gain in profitability last year. The ELECTRONIC BUSINESS top 100, the industry's most profitable public companies, increased their 1988 after-tax profits nearly 12% over the weighted average in 1987.

EUROPE BUSINESS

70 AEG: The centenarian refocuses on Europe, U.S.

This venerable German electronics company was down and out in 1982, but now is making a strong comeback with the help of its mighty parent Daimler-Benz. By way of its triad strategy, AEG aims to be a major player in the world's three most important markets: Asia, North America and Western Europe.

ASIA/PACIFIC BUSINESS

80 MITI explains why Japan is no copycat these days

Japan's days of borrowing technology from the United States are over, says that nation's trade ministry. A recent study of Japan's industrial technology concludes that Japan now originates 75% of the technology for most of its key high-tech products.

BUSINESS BAROMETER

89 Electronics trade

Exports of electronics products will continue to grow next year, although the rate is likely to be halved from the 1988 pace as the dollar stabilizes.

90 Leading indicator

Unexpected strength in U.S. semiconductor bookings is helping to hold up the indicator. The question now: How long will the plateau last?

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Inside Business

Market's message

The history of electronics is replete with solutions looking for problems — one of the latest, perhaps, being gallium arsenide semiconductors. As our new associate editor Mike Leibowitz reports, the GaAs chip makers are now beginning to find a wider range of applications for these blindingly fast devices by slowing them down a tad and making them more compatible with conventional silicon chips. Seems simple, doesn't it? Listen to the marketplace is the message, says Mike.

It's a message that Mike has heard before when he was a field sales engineer for Intel, selling microprocessors to a variety of industrial accounts, so he knows how to listen to customers. More recently, he has been marketing himself, as a successful freelance writer following his graduation from Boston University's school of journalism. He did that so well, appearing in the pages of *High Technology Business*, *Omni*, and *Computerworld*, to say nothing of regular contributions to ELECTRONIC BUSINESS, that we persuaded him to listen to us and join our staff full-time.

Mike is no stranger to the offices of ELECTRONIC BUSINESS. When he was studying for his master's degree, he also worked as an intern in our Newton editorial office. Clearly, we're a market Mike understands. In the weeks to come, Mike will be taking a closer look at several of the markets that make up this fascinating business of electronics.

Michael Leibowitz, associate editor

Listen to the future leaders

We've also been getting an earful from some of the brightest minds among the nation's top business and electrical engineering graduates. Associate editor Barbara Berkman and research supervisor Tom Sommers traveled from Boston to Philadelphia, Los Angeles and San Francisco to conduct a series of focus group research sessions with MBA and EE master's graduates at MIT, Wharton, UCLA and Stanford. We listened carefully to these future leaders' views on the worldwide electronics and computer industries, the companies they admire — and detest — and their expectations for the future. These men and women will set the course of America's business future, and their comments hold some important lessons for everyone in the business of electronics.

JEFF BAIRSTOW, executive editor

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BPA ABP

Europe begins to raise the barriers to imported ICs

Higher prices and IC shortages could result from a ruling requiring local wafer diffusion for a "Made in Europe" label

A recent ruling by the European Community (EC) could lead to artificial shortages and higher prices for semiconductors in Europe. The new rule regards ICs as "imported" unless the wafers undergo diffusion within the Community borders. The EC's Rules of Origin Commission is trying to ensure that "Made in Europe" computers and telecommunications equipment have a high level of locally made components.

The move is part of a general Community policy intended "to eliminate 'screwdriver' assembly factories," according to an EC spokesman. The ruling does not actually ban chips that are diffused in Japan or the United States and assembled in Europe, since there are no actual import quotas on semiconductors. But the move puts considerable pressure on OEMs that use the chips to make "Made in Europe" hardware. European hardware makers will have to include at least 60% local content in their equipment to avoid the payment of import duties.

"European hardware makers face a difficult choice," says Daniel Newman, an analyst at the consulting group Ernst & Whinney in Brussels. Either manufacturers will have to pay more for locally produced chips, he says, "or they could lose the right to call their machines European-made and their products will become subject to import duties. It may seem paradoxical that an Italian company like Olivetti should have to pay customs charges on the computers it manufactures in Italy, but that's what we could be seeing."

Bruno Lamborghini, director of research and strategy at Ing. C. Olivetti & Co., Europe's largest computer producer, stops short of calling the measure protectionist, but concedes that it is going to make life more difficult for Olivetti. "We do want European components," Lamborghini says, "but we expect to be able to buy them at competitive prices."

The ruling hits hardest at Japanese chip makers such as Toshiba Corp. and Hitachi Ltd. These producers assemble semiconductors in European factories, but diffuse them in Japan. Hitachi, for example, had European semiconductor sales of $320 million in 1988, but none of its chips undergo diffusion within the EC. Hitachi's products will now be counted as im-

IN THE KOREAN BUSINESS COMMUNITY
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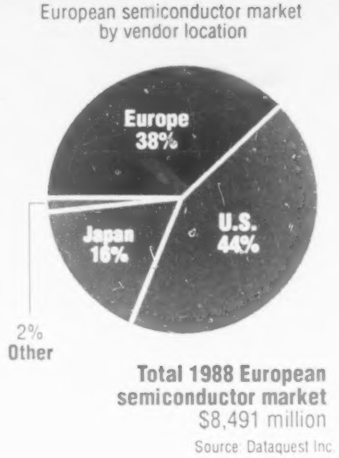
ports. And U.S. producer Intel Corp. is affected by the move, since it diffuses all of its chips in Israel, according to an Intel spokesman. "Israel has a privileged trading status with the EC. One of the many questions raised by the decision is whether that relationship will continue." Intel has asked the EC Commission to have its plant in Israel considered as European.

"Until there is a big ramp-up in European production by Japanese chip makers, the market is going to see an artificial shortage" of chips, says Dennis Exton, European technology analyst at the London stockbroker UBS-Phillips and Drew. "Of Japanese producers that sell in Europe," Exton adds, "only NEC already diffuses some of its semiconductors within the EC." Industry sources claim that foreign producers could take at least two years to gear up for diffusion.

Where Europe buys ICs

European semiconductor market by vendor location



Total 1988 European semiconductor market
$8,491 million

Source: Dataquest Inc.

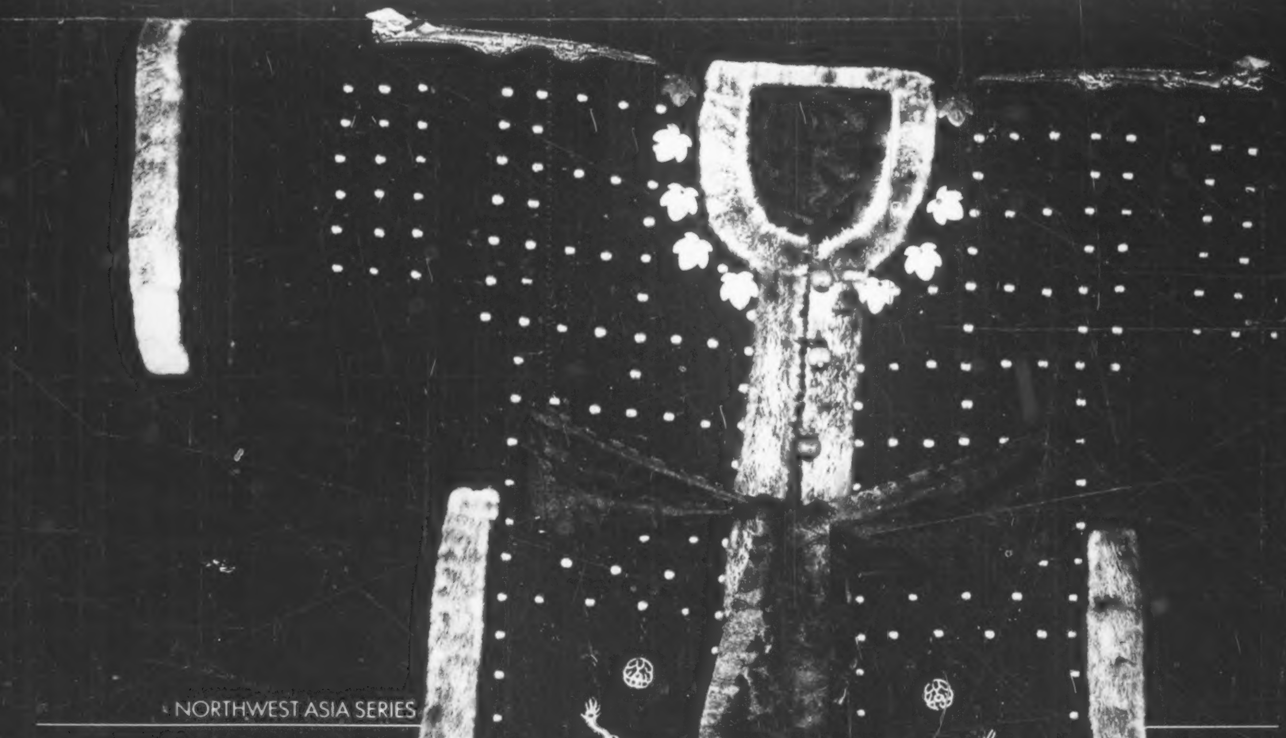
Even before the new law, EC equipment makers imported more than a third of their semiconductors. Last year, $8.5 billion in semiconductors were sold in Europe, $5.3 billion of which came from sources outside the Community, according to market research firm Dataquest Inc.

Analysts say it's too soon to estimate what proportion of European chip sales will be considered imported under the new rules, but it will certainly be higher than 50%. One of the areas hardest hit will be the memory market. In the past, hardware manufacturers could choose from several suppliers, including the European divisions of several Japanese companies, which assemble DRAMs in Europe but diffuse them elsewhere.

But under the new rules, West Germany's Siemens AG will be considered the only domestic producer of DRAMs in the Community. Siemens, however, can only supply 20% of the demand.

European prices for Japanese DRAMs may also climb if the commission institutes an antidumping ruling against Japanese-made DRAMs. Currently under consideration, this ruling could result in an accord similar to the U.S. Semiconductor Trade Agreement, which establishes "floor prices" (minimum prices) for Japanese memory chips.

ANDY ROSENBAUM



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Spurned GaAs chip makers resort to Marketing 101

New tactic of targeting silicon-compatible GaAs chips to relieve computer companies' "bottlenecks" is a departure from the past, when the thrust was speed

BY MICHAEL R. LEIBOWITZ

There have been many marketing blunders in the history of the electronics industry, but it is hard to find any more egregious than those committed by makers of digital gallium arsenide chips. For much of this decade, gallium arsenide chip makers have chased obscure markets, ignored potentially lucrative ones, and, in general, have earned the unwelcome reputation as purveyors of an exotic technology that few could afford and even fewer needed.

This could have gone on longer, with GaAs' prospects of hitting the computer mainstream evaporating, and no one missing it. But a new marketing tactic has emerged within the past two years that holds great promise for the tiny $50 million worldwide digital GaAs industry.

The new tactic involves what seems to be a perfectly obvious idea: trade some of the blinding speed of GaAs chips for other important benefits that system designers covet. This is a major departure from the way GaAs has been marketed in the past and threatens to wrench sales from makers of high-speed silicon chips. Right this minute, companies that never would be imagined using GaAs — makers of mainstream products such as workstations and minisupercomputers — are either considering it or designing it into their products.

GaAs, because of its natural characteristics, allows electrical signals to scream along at four to five times the speed of silicon. But the result has been superfast chips that could not work easily with silicon chips, didn't pack enough circuitry to be useful, and were too expensive. So why not give up some of GaAs' speed to overcome these problems? Specifically, why not turn out GaAs chips that work easily alongside silicon chips so they can be sold as so-called "bottleneck relievers," providing an added fillip of speed to high-traffic areas of a silicon-based computer design?

This idea, called "silicon compatibility," is being pursued by each of today's four U.S. merchant GaAs chip makers — Gazelle Microcircuits Inc., GigaBit Logic Inc., TriQuint Semiconductor Inc. and Vitesse Semiconductor Corp. The concept involves technology enhancements that eliminate the strange power supply requirements of GaAs chips, matching them to the industry-standard power levels of silicon chips. It also involves adding on-chip circuitry that brings GaAs input/output levels in line with those of silicon emitter-coupled logic (ECL) and transistor-transistor logic (TTL) chips. While this slows down the chip somewhat, the resulting chips are at least twice as fast as silicon. Most importantly, such silicon-compatible chips give

Lou Tomasetta, chief executive of Vitesse: "The strategy once was, 'Gee, here's this stuff I developed in the R&D lab. Now let me see if I can sell it' "

Michael Grecco

Jerry Crowley, chief executive of Gazelle: "You take an exotic material that has inherently faster properties and you tame it and make it usable by the masses"

workstation makers a cost effective way to squeeze extra MIPS from a high-end design.

There's another twist to the silicon-compatibility thrust: trim the speed, cram in more circuitry, and emphasize GaAs' low-power advantages over silicon. A 10,000-gate GaAs array slowed so it is only 20% faster than the fastest 10,000-silicon gate ECL chip, for example, runs with less than half the power. Offering such cool-running, silicon-compatible GaAs chips — a route Vitesse is promoting — means potential customers such as minisupercomputer builders can dilute the mix of power-hungry silicon chips in their design, and thus avoid having to add expensive and bulky mechanical cooling systems to their products. "Staying in the air-cooled domain is very important to us," says Steven Wallach, cofounder and vice president of technology at Convex Computer Corp. of Richardson, Texas, the leading maker of minisupercomputers. "Chips get cheaper over time. Mechanics don't."

Once reluctant to trade speed

Trading some speed for these other benefits seems a natural tactic for chip makers, but it was heresy to the first suppliers of digital GaAs. Between 1981 and 1986, companies such as GigaBit Logic and Harris Corp. were fixated on speed, trying to build the fastest parts that GaAs would allow. While they did create parts four to five times as fast, these parts didn't fit well with silicon circuitry and were outrageously expensive. "The strategy," says Vitesse's chief executive, Lou Tomasetta, "was, 'Gee, here's this stuff I developed in the R&D lab. Now let me see if I can sell it.'"

Except for a few exotic digital GaAs applications, they couldn't. Chip makers targeted speed-at-any-cost customers such as the military and Cray Research Inc., that could afford to build entire subsystems out of GaAs chips and didn't care much about the lack of silicon compatibility. They loved the technology, but were on such long design cycles that it would be many years before they could generate any significant production volume. And without production volume, the GaAs chip makers were stuck in a vicious circle: Low demand, high costs — and no way to move along the GaAs learning curve to lower costs and increased chip complexity. Instead of topping $1 billion in annual sales by 1988, as had been projected years ago, the digital GaAs IC business, today, is no more than a speck in the $36 billion silicon IC business.

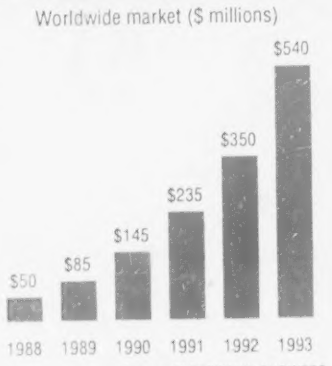
Silicon compatibility

Enter silicon compatibility. It is still very early, but there are clear signs of success. Already, Convex is likely to use silicon-compatible GaAs in its next generation of minisupercomputers, says technology chief Wallach, "in sufficient volume to make a vendor very happy." (In April, Robert Paluck, chief executive at Convex, joined Vitesse's board of directors.) Sun Microsystems Inc., the No. 1 workstation vendor, could use up to 20 silicon-compatible GaAs chips per system in upcoming high-end products, according to David Ditzel, manager of advanced architecture. And Joseph Zeh, group manager of large VAX engineering at Digital Equipment Corp., says, "It's not unreasonable to think" that GaAs parts would show up in Digital's products within two years.

Growth expected

With such applications in the digital mainstream, as well as GaAs' more traditional ones outside of it (such as the GaAs-based Cray-3 supercomputer), industry experts agree that the GaAs market is poised for tremendous growth. Based on discussions with users, vendors and analysts, ELECTRONIC BUSINESS projects that the worldwide merchant market for digital GaAs chips will increase 70% in 1990 to $145 million, and continue growing an average 55% a year to $540 million by 1993. Silicon compatible parts are expected to account for the lion's share of this growth and much of this business will

Digital merchant GaAs IC revenue



Source: ELECTRONIC BUSINESS

Linda Sue Scott

GaAs solutions

GaAs chip makers are now attacking these speed bottlenecks in computers:

- Cache control logic
- Bus arbitration control logic
- High-speed DRAM control logic
- Fractional wait-state generation logic
- Multiport register files
- Floating point processors
- Video graphics processors

come at the expense of high-speed silicon IC makers.

The silicon compatibility tactic was established by Vitesse and Gazelle, both coming on the scene after GaAs was already in trouble. "We had the ability to watch what had happened," acknowledges Vitesse's Tomasetta. Vitesse, a 1984 start-up based in Camarillo, Calif., saw that the market did not want to adopt a radically different IC technology; it wanted parts that offered improvements over existing silicon technology. Consequently, the company began developing a technology for producing digital GaAs parts that looked just like silicon parts, and which could either be used for addressing speed bottlenecks in systems, or for reducing the power requirements of a predominantly silicon system.

Increased GaAs sales expected

Vitesse turned out to be silicon compatibility's first active promoter. After it introduced an unpopular GaAs version of Advanced Micro Devices' 2901 bit-slice processor, Vitesse found success with the TTL- and ECL-compatible GaAs gate array family which it introduced in 1987. Today, Vitesse's gate arrays, which go up to 15,000 gates, are its most popular parts, according to Tomasetta. The company reached roughly $4 million in sales for fiscal 1988, and, riding a wave of major design-ins in the computer industry, Tomasetta expects Vitesse to triple its revenue to $12 million in 1989 and double it to $25 million or $30 million in 1990. By 1991, Tomasetta says 50% to 60% of Vitesse's revenue to come from high-end PC, workstation and minisupercomputer makers. The remaining will come from a mix of telecommunications, military and test equipment accounts.

The promise of silicon compatibility was obvious, says Jerry Crowley, chief executive of Gazelle, who cites this as the reason he left his CEO post at Oki Semiconductor Inc. at the end of 1986 to join the start-up. "You take an exotic material that has inherently faster properties and you tame it and make it usable by the masses."

Crowley's company, a brash marketing and design company that has raised $13.2 million from a *Who's*

How two companies figured out how to market GaAs

It is easy to figure out a marketing tactic when you're selling something popular. But it's a little more difficult when everyone laughs at you. In the case of Vitesse Semiconductor Corp. and Gazelle Microcircuits Inc., each company developed its product tactics in the midst of a market that had spurned GaAs, where the general consensus was that GaAs chip makers were courting oblivion. In doing so these companies broke with the way it had been done in GaAs' past and followed one of the principles of savvy marketing: find out what the market wants.

Vitesse's first good move was realizing it was not going to radically change computer designers' habits with GaAs — as the other GaAs chip makers were trying to do. "We started from a silicon status quo, and tried to improve on that," says Lou Tomasetta, Vitesse's president and CEO.

From there, Vitesse talked with approximately 40 potential supercomputer and mainframe customers in 1986 to find out what improvements they wanted in the silicon parts they were using. What Vitesse discovered was surprising. "What struck us was that the most important thing wasn't speed," says Tomasetta. "It was complexity and power — and then speed." This translated into Vitesse's tactic of developing silicon-compatible parts that traded off some speed for higher complexity and lower power.

Gazelle also talked to potential customers, but with an eye toward the burgeoning workstation and high-end PC market, which it had identified as a prime prospect for silicon-compatible GaAs in speed bottlenecks caused by the new breed of galloping microprocessors. Cofounders David MacMillan and Andrew Graham interviewed between 60 and 70 potential workstation and computer accounts during the company's start-up, between 1985 and 1986, to determine what computer architects require in order to step up their system's performance and what trade-offs they were willing to make, according to MacMillan, now vice president for marketing.

Gazelle and Vitesse quizzed scores of computer makers to learn what they *really* wanted

Midcourse corrections

From that information, "we made a number of midcourse corrections," MacMillian says. Among them were targeting the 22V10 programmable logic device, instead of bit-slice processors, and striving for a shortened address set-up time, a specification that would greatly boost the speed of the customers' systems.

Talking to customers was important, says MacMillan. "The basic trends ended up being pretty obvious," he says. "What becomes very difficult is how you take that trend and turn it into a product that's going to be successful."

Tomasetta of Vitesse agrees, adding that there is no distinct GaAs market for chip makers to tap. "There's not a bunch of people out there waiting for GaAs. The market can be gigantic or small, depending on the products you build." ☐

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Who list of venture capitalists, grabbed the industry's attention in 1988 with its first product: a GaAs version of the industry-standard 22V10 programmable logic device. The part drops into a silicon 22V10 socket and runs more than twice as fast. While Crowley is sworn to secrecy about who is designing with it, he says the names are big and they will be known by year-end.

Earlier revenue

Since customers can install the part into existing designs without modification, Gazelle will not have to wait years to see it generate revenue, he adds. Along with upcoming datacommunication products, Crowley says Santa Clara, California-based Gazelle will be a $225 million company in 1992. According to market research firm Forward Concepts Co. of Tempe, Ariz., Gazelle's 1988 sales were less than $1 million.

As for the two older GaAs chip makers, GigaBit and TriQuint, both companies now offer silicon-compatible digital products. GigaBit, based in Newbury Park, Calif., still appears to be focused, however, [illegible] GaAs-intensive applications outside [illegible] the silicon mainstream, with 60% of its nearly $15 million in 1988 revenue coming from its foundry deal with Cray. "Their thrust is to place GaAs in a sea of GaAs," according to Forward Concepts president William I. Strauss. TriQuint, too, of Beaverton, Ore., is focused primarily on foundry business, where it produces chips for such customers as Gazelle. Its revenue is centered in military and telecom accounts, and it lacks a concerted push in the computer area. TriQuint reached $18 million in 1988 sales, according to Forward Concepts.

Each of the four chip makers expect digital GaAs to be commonplace in supercomputers and other low-volume, high-end machines within the next several years. But Vitesse and Gazelle say that by the end of this year, a raft of high-volume computer makers will announce systems that incorporate silicon-compatible GaAs. If this happens, it will be quite a victory. In this case, a unique market strategy will have removed GaAs from the trash heap of technologies, which includes bubble memories and Picturephones, which never quite found a mainstream market. ☐

Coining it: Top U.S. firms show 12% profits gain

Averaging 8.7% after-tax profit in '88, the 100 most profitable U.S. electronics firms net 64% more than U.S. industry overall

BY RAY WISE

Paced by the high-flying semiconductor, systems and government groups, the elite of the U.S. electronics industry posted another hefty year-to-year gain in profitability last year.

The ELECTRONIC BUSINESS top 100, the industry's most profitable public companies, crossed the tape last December 31 with a weighted average after-tax profit margin of 8.7%, a jump of nearly 12% over the year-earlier profitability of 7.8%.

The 1988 profit margin of the top 100 represents a 64% superiority over the 5.3% profitability of the average U.S. industrial company. The least profitable enterprise in the top 100, Kulicke & Soffa Industries Inc., a maker of semiconductor capital equipment, posted an after-tax margin of 5.2%, just about matching the all-industry average.

This latest top 100 report only heightens the stark contrast between the outstanding financial performance of high tech's leading companies and their lack of recognition on Wall Street, where their stock market valuations have been at historical lows on and off since 1983.

The top two ventures of the top 100, Micron Technology Inc., a semiconductor maker, and Symbol Technologies Inc., which is in the bar-code scanner business, had not even made the cut in last year's ELECTRONIC BUSINESS rankings of the most profitable. This time around they came in with awesome profit margins of 32.6% and 22.7%, respectively.

Such is the dynamism of this growth industry that there were eight outfits in the 1988 top 20 that weren't even eligible for the top 100 in '87. Five of the top 20 companies are in semiconductors, another five are in software, and only three make computers: Cray Research Inc., Altos Computer Systems and Compaq Computer Corp.

Technically, the office equipment group scored the biggest year-to-year profitability gain, a resounding 47%, but this was a statistical fluke. Low-margin Xerox Corp. fell out of the rankings in 1988, shrinking the office equipment group to three much more profitable companies. But Diebold Inc. and NCR Corp. slipped in profitability year to year, and Pitney Bowes Inc. was flat. What at first sight looked like a homer, turned out to be a run driven in by a base on balls.

Kevin Hawkes

The batting crown really belongs to the semiconductor group, whose after-tax profit margin improved 42% from 1987 to 1988.

Cray Research Inc., which nailed down first place in last year's top 100 with a 21.4% profit margin, fell to the fourth spot as its profitability slipped to 20.7% — a nominal decline. Cray's revenue expanded a healthy 10% last year, but the company has been corralling commercial customers, which tend to lease rather than buy. Cray derives fatter profits from its traditional marketplace — government agencies and universities — which usually purchase its supercomputers.

Setbacks

The biggest year-to-year profitability setback among the companies entered in both last year's and this year's top 100 fell to Tandem Computers Inc., which had a drop of 29%. But that's not as onerous as it sounds; Tandem, with an eye to its future, spends heavily, developing new markets and new technology, with the result that it does not always convert sales growth into higher earnings.

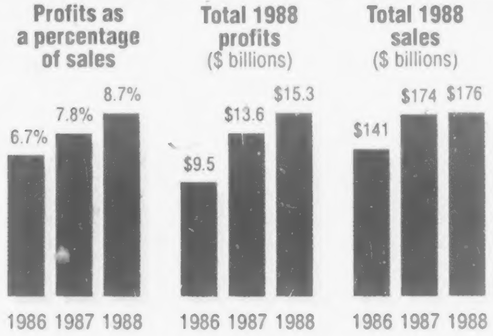
In the bombed-out computer peripherals group (income down nearly 25% in '88), a 58% plunge in the profitability of disk-drive giant Seagate Technology masked outstanding gains by other peripherals makers. Tape drive firm Archive chalked up a net margin gain of 25%, and fellow peripherals firms Applied Magnetics and Emulex saw net margin gains of 21% and more than 100%, respectively. ☐

Facts behind the figures

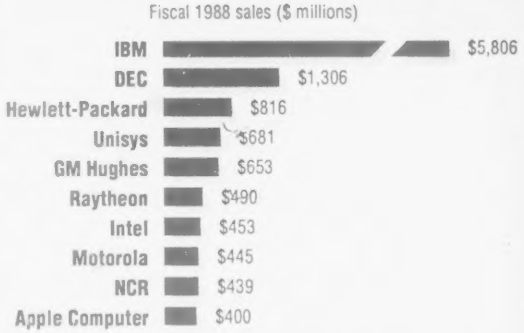
On the pages that follow, ELECTRONIC BUSINESS provides a listing of the 100 most profitable U.S. electronics firms. They are all publicly held with sales of $80 million or more, and are ranked in order of their ratio of net income to revenue for fiscal 1988.

U.S. firms have been posting better profits. Net income as a percentage of sales for the 100 most profitable climbed from 6.7% in 1986 to 7.8% in 1987, and last year it hit 8.7% — consistently better than the comparable 4.1%, 4.8% and 5.3% averages for U.S. industry in the same years.

The overall picture



Who made the most profits



Here are the sheer profits

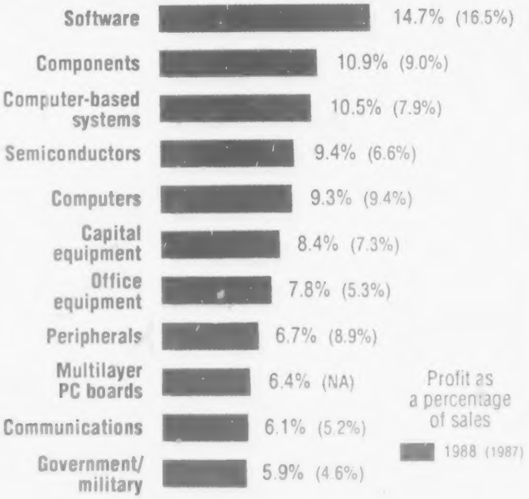
Quick quiz: On average, what was IBM's 1988 profit per day? The answer: almost $16 million. At $5.8 billion, the after-tax income of the United States electronics industry's largest company —IBM — is a figure that big boys such as NCR Corp. barely top in revenue. That figure is over twice as large as the sales of chip maker Intel Corp. and nearly three times as large as rival Compaq Computer Corp.'s sales.

Software's where the money is

In most industry segments, profitability climbed from 1987 to 1988. U.S. semiconductor makers showed one of the strongest gains — from 6.6% to 9.4% net income over sales. Components makers did well too, posting almost 11% after-tax.

Three sectors slipped in the income ratings: it's been no secret that computer peripherals firms, notably disk drive makers, have been under intense competitive pressure to make a buck. Computer makers lost some, and software firms slid, although software's still way out in front.

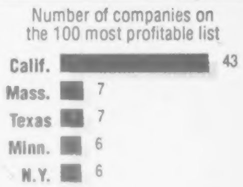
Most profitable industry segments



They don't just soak in hot tubs

Most of the most profitable U.S. electronics companies are in California — 43 of the top 100. A quick comparison with last year's list: the number of profitable companies in California grew from 37.

Hot profit spots



1988's most profitable U.S. companies

Rank	Company	Profit as a percentage of sales	Fiscal year 1988 sales ($ millions)	Fiscal year 1988 profits ($ millions)	Fiscal year ended	Location
1	**Micron Technology**	32.6%	$300.5	$98.0	8/88	Boise, Idaho
2	**Symbol Technologies**	22.7%	89.0	20.2	6/88	Bohemia, N.Y.
3	**Microsoft**	21.0%	590.8	123.9	6/88	Redmond, Wash.
4	**Cray Research**	20.7%	756.3	156.6	12/88	Minneapolis, Minn.
5	**Digital Communications Associates**	18.6%	227.5	42.2	6/88	Alpharetta, Ga.
6	**Intel**	15.8%	2,874.8	452.9	12/88	Santa Clara, Calif.
7	**Chips and Technologies**	15.6%	141.5	22.1	6/88	San Jose, Calif.
8	**Ashton-Tate**	15.6%	307.3	47.8	1/88	Torrance, Calif.
9	**Xicor**	15.5%	90.1	14.0	12/88	Milpitas, Calif.
10	**Oracle Systems**	15.2%	282.1	42.9	5/88	Belmont, Calif.
11	**Cypress Semiconductor**	14.9%	139.4	20.8	12/88	San Jose, Calif.
12	**Computer Associates**	14.4%	709.1	101.8	3/88	Garden City, N.Y.
13	**Vishay Intertechnology**	14.2%	109.0	15.5	6/88	Malvern, Pa.
14	**Measurex**	14.0%	265.2	37.1	11/88	Cupertino, Calif.
15	**Medtronic**	13.2%	653.3	86.5	4/88	Minneapolis, Minn.
16	**Network Equipment Technologies**	13.1%	90.6	11.9	3/88	Redwood City, Calif.
17	**National Computer Systems**	12.7%	209.2	26.5	1/89	Minneapolis, Minn.
18	**Altos Computer Systems**	12.6%	175.9	22.2	6/88	San Jose, Calif.
19	**Lotus Development**	12.6%	468.5	58.9	12/88	Cambridge, Mass.
20	**Compaq Computer**	12.4%	2,065.6	255.2	12/88	Houston, Texas
21	**AMP**	11.9%	2,670.0	319.0	12/88	Harrisburg, Pa.
22	**Amdahl**	11.9%	1,801.8	213.8	12/88	Sunnyvale, Calif.
23	**Molex**	11.8%	502.4	59.3	6/88	Lisle, Ill.
24	**DEC**	11.4%	11,475.4	1,305.6	6/88	Maynard, Mass.
25	**Telxon**	11.3%	123.9	14.0	3/88	Akron, Ohio
26	**Gerber Scientific**	11.2%	264.0	29.6	4/88	South Windsor, Conn.
27	**Mentor Graphics**	11.2%	300.8	33.5	12/88	Beaverton, Ore.
28	**Stratus Computer**	11.1%	265.3	29.3	12/88	Marlboro, Mass.
29	**Applied Materials**	11.0%	362.8	40.0	10/88	Santa Clara, Calif.
30	**Intergraph**	11.0%	800.2	88.0	12/88	Huntsville, Ala.
31	**Novell**	10.8%	281.2	30.4	10/88	Provo, Utah
32	**Silicon Systems**	10.5%	120.8	12.7	9/88	Tustin, Calif.
33	**Apple Computer**	9.8%	4,071.4	400.3	9/88	Cupertino, Calif.
34	**Integrated Device Technology**	9.6%	121.1	11.6	3/88	Santa Clara, Calif.
35	**Richardson Electronics**	9.5%	118.3	11.2	5/88	La Fox, Ill.
36	**Teradata**	9.5%	89.5	8.5	6/88	Los Angeles, Calif.
37	**ADC Telecommunications**	9.4%	179.9	17.0	10/88	Bloomington, Minn.
38	**IBM**	9.2%	59,681.0	5,806.0	12/88	Armonk, N.Y.
39	**3Com**	8.9%	251.9	22.5	5/88	Santa Clara, Calif.
40	**Pitney Bowes**	8.9%	2,649.9	237.0	12/88	Stamford, Conn.
41	**Plantronics**	8.9%	121.0	10.7	6/88	San Jose, Calif.
42	**Atari**	8.7%	452.2	39.4	12/88	Sunnyvale, Calif.
43	**Tellabs**	8.7%	155.4	13.5	12/88	Lisle, Ill.
44	**Analog Devices**	8.6%	439.2	38.0	10/88	Norwood, Mass.
45	**Network Systems**	8.6%	131.5	11.4	12/88	Minneapolis, Minn.
46	**Systematics**	8.6%	179.5	15.4	8/88	Little Rock, Ark.
47	**Archive**	8.6%	122.7	10.5	9/88	Costa Mesa, Calif.
48	**Tandy**	8.3%	3,793.8	316.4	6/88	Fort Worth, Texas
49	**Hewlett-Packard**	8.3%	9,831.0	816.0	10/88	Palo Alto, Calif.
50	**Silicon Graphics**	8.2%	152.6	12.5	6/88	San Jose, Calif.

(Continued)

Electronic Business

1988's most profitable U.S. companies

Rank	Company	Profit as a percentage of sales	Fiscal year 1988 sales ($ millions)	Fiscal year 1988 profits ($ millions)	Fiscal year ended	Location
51	**Applied Magnetics**	8.1%	$293.0	$23.7	9/88	Goleta, Calif.
52	**Conner Peripherals**	7.9%	256.6	20.3	12/88	San Jose, Calif.
53	**KLA Instruments**	7.8%	112.9	8.8	6/88	Santa Clara, Calif.
54	**Iomega**	7.7%	111.5	8.6	12/88	Roy, Utah
55	**Ask Computer Systems**	7.6%	142.4	10.8	6/88	Los Altos, Calif.
56	**NCR**	7.3%	5,989.9	439.3	12/88	Dayton, Ohio
57	**Emulex**	7.3%	125.1	9.1	6/88	Costa Mesa, Calif.
58	**Tandem Computers**	7.2%	1,314.7	94.5	9/88	Cupertino, Calif.
59	**MTS Systems**	7.1%	128.9	9.1	9/88	Minneapolis, Minn.
60	**Watkins-Johnson**	7.0%	292.2	20.6	12/88	Palo Alto, Calif.
61	**Diceon Electronics**	7.0%	140.7	9.9	9/88	Irvine, Calif.
62	**Diebold**	7.0%	450.6	31.3	12/88	Canton, Ohio
63	**BancTec**	6.9%	93.4	6.4	3/88	Dallas, Texas
64	**Unisys**	6.9%	9,902.0	680.6	12/88	Detroit, Mich.
65	**Data-Design Laboratories**	6.8%	107.0	7.3	6/88	Cucamonga, Calif.
66	**AVX**	6.7%	408.9	27.6	12/88	Great Neck, N.Y.
67	**Dynatech**	6.7%	367.8	24.5	3/88	Burlington, Mass.
68	**Burr-Brown**	6.5%	176.7	11.5	12/88	Tucson, Ariz.
69	**Triad Systems**	6.5%	127.4	8.3	9/88	Livermore, Calif.
70	**Oak Industries**	6.5%	197.8	12.9	12/88	Rancho Bernardo, Calif.
71	**Sun Microsystems**	6.3%	1,051.6	66.4	6/88	Mountain View, Calif.
72	**LSI Logic**	6.3%	378.9	23.8	12/88	Milpitas, Calif.
73	**Ultimate**	6.2%	209.2	13.0	4/88	East Hanover, N.J.
74	**Intermec**	6.1%	85.2	5.2	3/88	Lynnwood, Wa.
75	**Wyse Technology**	6.1%	456.6	28.0	3/88	San Jose, Calif.
76	**Seagate Technology**	6.1%	1,266.0	77.3	6/88	Scotts Valley, Calif.
77	**Finnigan**	6.0%	130.7	7.8	12/88	San Jose, Calif.
78	**Raytheon**	6.0%	8,192.0	489.6	12/88	Lexington, Mass.
79	**Bolt Beranek and Newman**	5.9%	305.2	18.1	6/88	Cambridge, Mass.
80	**DSC Communications**	5.9%	339.7	20.0	12/88	Plano, Texas
81	**Scientific-Atlanta**	5.8%	508.6	29.7	6/88	Atlanta, Ga.
82	**Texas Instruments**	5.8%	6,294.8	366.3	12/88	Dallas, Texas
83	**MAI Basic Four**	5.8%	420.8	24.5	9/88	Tustin, Calif.
84	**GM Hughes Electronics**	5.8%	11,243.6	653.3	12/88	Detroit, Mich.
85	**Rexon**	5.8%	155.5	9.0	9/88	Culver City, Calif.
86	**General Instrument**	5.7%	1,155.5	66.2	2/88	New York, N.Y.
87	**Eldec**	5.6%	104.1	5.9	3/88	Lynnwood, Wash.
88	**Cipher Data Products**	5.6%	185.4	10.4	6/88	San Diego, Calif.
89	**Valid Logic Systems**	5.6%	108.4	6.1	12/88	San Jose, Calif.
90	**Dell Computer**	5.6%	257.8	14.4	1/89	Austin, Texas
91	**Western Digital**	5.6%	768.3	43.0	6/88	Irvine, Calif.
92	**Fluke**	5.5%	224.5	12.4	9/88	Everett, Wash.
93	**Park Electrochemical**	5.5%	128.1	7.0	2/88	Lake Success, N.Y.
94	**Andrew**	5.5%	253.5	13.9	9/88	Orland Park, Ill.
95	**Concurrent Computer**	5.5%	263.1	14.4	6/88	Tinton Falls, N.J.
96	**MSI Data**	5.5%	90.2	4.9	3/88	Costa Mesa, Calif.
97	**Convex Computer**	5.4%	105.6	5.7	12/88	Richardson, Texas
98	**Sparton**	5.4%	206.3	11.2	6/88	Jackson, Mich.
99	**Motorola**	5.4%	8,250.0	445.0	12/88	Schaumburg, Ill.
100	**Kulicke and Soffa**	5.2%	83.5	4.4	9/88	Willow Grove, Pa.

Source: ELECTRONIC BUSINESS

Electronic Business

1988's most profitable U.S. companies by industry segment

Capital equipment

	Profit as a percentage of sales	1988 rank
Vishay Intertechnology	14.2%	13
Gerber Scientific	11.2%	26
Applied Materials	11.0%	29
Hewlett-Packard	8.3%	49
KLA Instruments	7.8%	53
MTS Systems	7.1%	59
Fluke	5.5%	92
Kulicke and Soffa	5.2%	100
Weighted average	**8.4%**	

Communications

	Profit as a percentage of sales	1988 rank
Digital Communications Associates	18.6%	5
Network Equipment Technologies	13.1%	16
Novell	10.8%	31
ADC Telecommunications	9.4%	37
3Com	8.9%	39
Tellabs	8.7%	43
Network Systems	8.6%	45
Dynatech	6.7%	67
Bolt Beranek and Newman	5.9%	79
DSC Communications	5.9%	80
Scientific-Atlanta	5.8%	81
General Instrument	5.7%	86
Andrew	5.5%	94
Motorola	5.4%	99
Weighted average	**6.1%**	

Components (other than semiconductors)

	Profit as a percentage of sales	1988 rank
AMP	11.9%	21
Molex	11.8%	23
AVX	6.7%	66
Oak Industries	6.5%	70
Eldec	5.6%	87
Weighted average	**10.9%**	

Computer-based systems

	Profit as a percentage of sales	1988 rank
Symbol Technologies	22.7%	2
Measurex	14.0%	14
National Computer Systems	12.7%	17
Telxon	11.3%	25

(Continued)

Computer-based systems (continued)

	Profit as a percentage of sales	1988 rank
Mentor Graphics	11.2%	27
Ask Computer Systems	7.6%	55
BancTec	6.9%	63
Triad Systems	6.5%	69
Finnigan	6.0%	77
Valid Logic Systems	5.6%	89
MSI Data	5.5%	96
Weighted average	**10.5%**	

Computers

	Profit as a percentage of sales	1988 rank
Cray Research	20.7%	4
Altos Computer Systems	12.6%	18
Compaq Computer	12.4%	20
Amdahl	11.9%	22
DEC	11.4%	24
Stratus Computer	11.1%	28
Intergraph	11.0%	30
Apple Computer	9.8%	33
Teradata	9.5%	36
IBM	9.2%	38
Atari	8.7%	42
Tandy	8.3%	48
Silicon Graphics	8.2%	50
Tandem Computers	7.2%	58
Unisys	6.9%	64
Sun Microsystems	6.3%	71
MAI Basic Four	5.8%	83
Rexon	5.8%	85
Dell Computer	5.6%	90
Concurrent Computer	5.5%	95
Convex Computer	5.4%	97
Weighted average	**9.3%**	

Government

	Profit as a percentage of sales	1988 rank
Watkins-Johnson	7.0%	60
Raytheon	6.0%	78
GM Hughes Electronics	5.8%	84
Spartor	5.4%	98
Weighted average	**5.9%**	

Multilayer circuit boards

	Profit as a percentage of sales	1988 rank
Diceon Electronics	7.0%	61
Data-Design Laboratories	6.8%	65
Park Electrochemical	5.5%	93
Weighted average	**6.4%**	

Office equipment

	Profit as a percentage of sales	1988 rank
Pitney Bowes	8.9%	40
NCR	7.3%	56
Diebold	7.0%	62
Weighted average	**7.8%**	

Peripherals

	Profit as a percentage of sales	1988 rank
Archive	8.6%	47
Applied Magnetics	8.1%	51
Conner Peripherals	7.9%	52
Iomega	7.7%	54
Emulex	7.3%	57
Intermec	6.1%	74
Wyse Technology	6.1%	75
Seagate Technology	6.1%	76
Cipher Data Products	5.6%	88
Weighted average	**6.7%**	

Semiconductors

	Profit as a percentage of sales	1988 rank
Micron Technology	32.6%	1
Intel	15.8%	6
Chips and Technologies	15.6%	7
Xicor	15.5%	9
Cypress Semiconductor	14.9%	11
Silicon Systems	10.5%	32
Integrated Device Technology	9.6%	34
Richardson Electronics	9.5%	35
Analog Devices	8.6%	44
Burr-Brown	6.5%	68
LSI Logic	6.3%	72
Texas Instruments	5.8%	82
Western Digital	5.6%	91
Weighted average	**9.4%**	

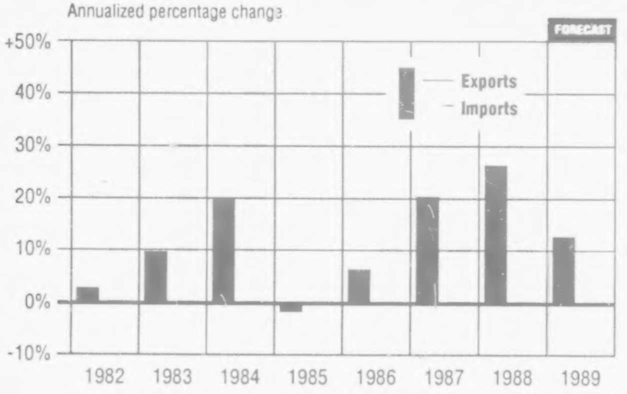
Software

	Profit as a percentage of sales	1988 rank
Microsoft	21.0%	3
Ashton-Tate	15.6%	8
Oracle Systems	15.2%	10
Computer Associates	14.4%	12
Lotus Development	12.6%	19
Systematics	8.6%	46
Ultimate	6.2%	73
Weighted average	**14.7%**	

Net profits are from continuing operations after taxes and before extraordinary items

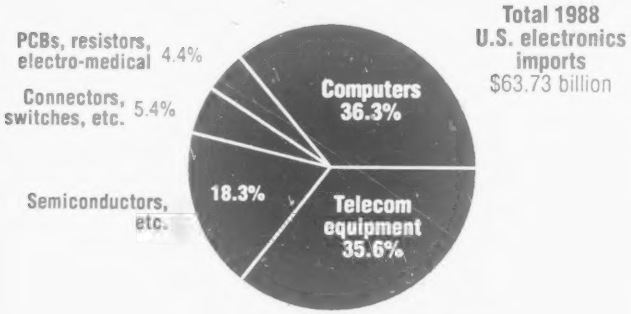
Source: ELECTRONIC BUSINESS

U.S. electronics exports and imports



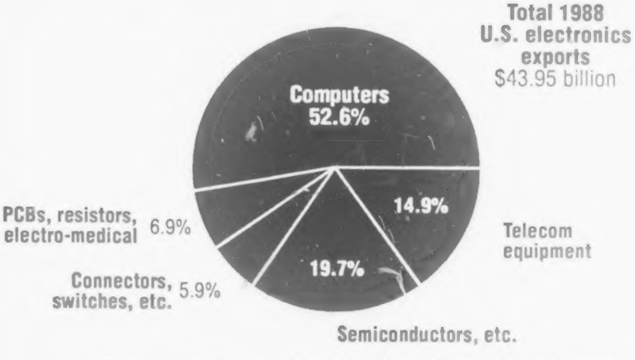
Data source: U.S. International Trade Administration; Forecast: Cahners Economics

1988 U.S. electronics imports



Data source: U.S. International Trade Administration; Forecast: Cahners Economics

1988 U.S. electronics exports



Data source: U.S. International Trade Administration; Forecast: Cahners Economics

U.S. electronics exports grow and grow

U.S. electronics manufacturers exported $11.83 billion worth of products in the fourth quarter of 1988 — a surge of 19% over the fourth quarter 1987 level, according to International Trade Administration estimates. The U.S. dollar's decline over the past two years was just what the electronics industry needed. U.S. electronics exports expanded 20% in 1987 and another 26% in 1988, for an annual total last year of $43.95 billion.

The depreciating greenback also finally resulted in some noticeable softening in the growth rate of electronics imports. In the final quarter of last year, imports of electronics products tallied $17.63 billion, a gain of 15.5% over the same quarter of 1987. Although still a hefty increase, that growth was down from the gains recorded in the first three quarters of last year. For all of 1988, electronics imports advanced 18.8% to $63.73 billion.

Unfortunately for the U.S. trade picture, the electronics trade deficit in 1988 weighed in at $19.77 billion — up almost 5% from the $18.84 billion the year before. With the exceptions of computing machines, electromedical equipment, and printed circuit boards, the U.S. imported more than it exported last year. Not since 1982 has U.S. electronics trade run a surplus.

The appreciating dollar earlier in the decade left the gates wide open for a flood of imports into the U.S. and, at the same time, influenced U.S. companies to locate offshore. Thus, the development of foreign economies and multinational corporations has changed the patterns of global trade.

Forecasting future trade developments

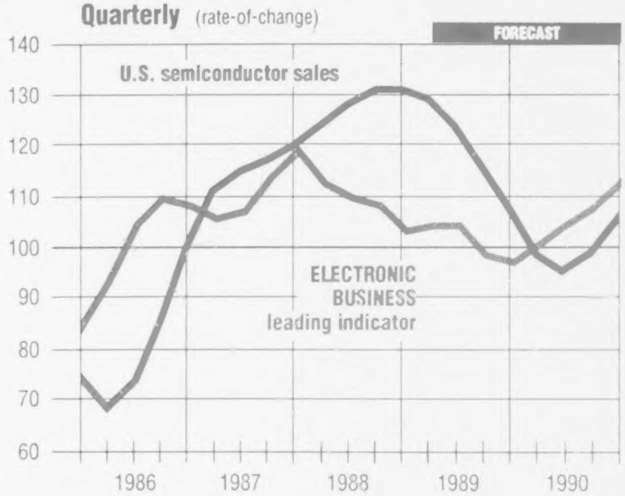
According to our estimates at Cahners Economics, exports of electronics products will continue to grow this year and next although the rate is likely to be halved from the 1988 pace as the dollar stabilizes. A weaker U.S. economy will also put the lid on import growth, keeping the annual increase below the export rate for the third straight year.

Of course, any forecast on future export and import trends depends on forecasts for the U.S. dollar. Forecasting the dollar is an especially risky business, but Cahners Economics assumes the value of the dollar will rise a marginal 0.5% to 1% in 1989. The ultimate result: the big bonuses to U.S. exporters from a sharply falling dollar clearly appear to be over for the next 12 months.

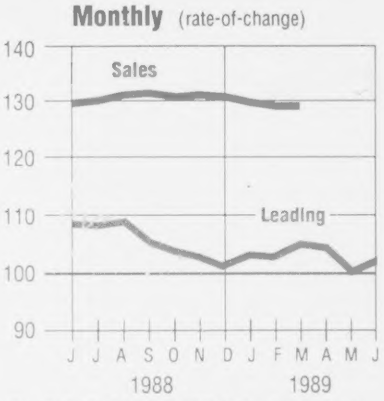
MADELINE FRANCHI, ELIZABETH B. BAATZ

This topic is scheduled to appear again in the December 11th issue.

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368



The ELECTRONIC BUSINESS leading indicator held relatively steady at 102.7 in February, down from a revised 103.3 in January. Unexpected strength in U.S. semiconductor bookings is helping to hold up the indicator. The question now: How long will this plateau last? Cahners' forecast suggests the indicator will drop to 95 by September and then rise again afterward.

Source: Cahners Economics

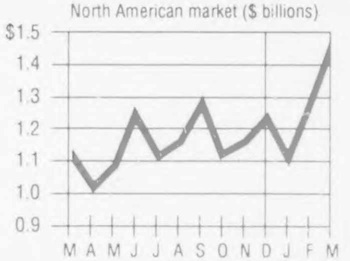
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Feb.)	102.7	103.3	112.1	107.6
U.S. semiconductor bookings ($ millions, 3-month average, March)	$1,345	$1,243	$1,142	$1,178
Weekly hours of semiconductor production workers (monthly average, Feb.)	39.3	40.0	40.2	40.2
Electronic components leadtime index (1977 = 100, April)	117.7	117.7	106.5	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, Mar.)	47.4	51.0	59.2	54.4
Change in electronic components inventories ($ millions, SA, Feb.)	+$94	+$50	+$123	+$80
Contract and orders for plant and equipment ($ billions, SA, Feb.)	$41.0	$45.0	$39.5	$39.4

SA = seasonally adjusted, all other data is not seasonally adjusted

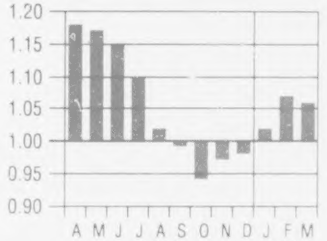
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



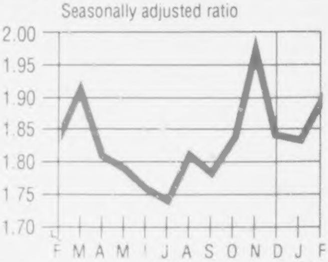
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department

SIX DOLLARS

A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORL

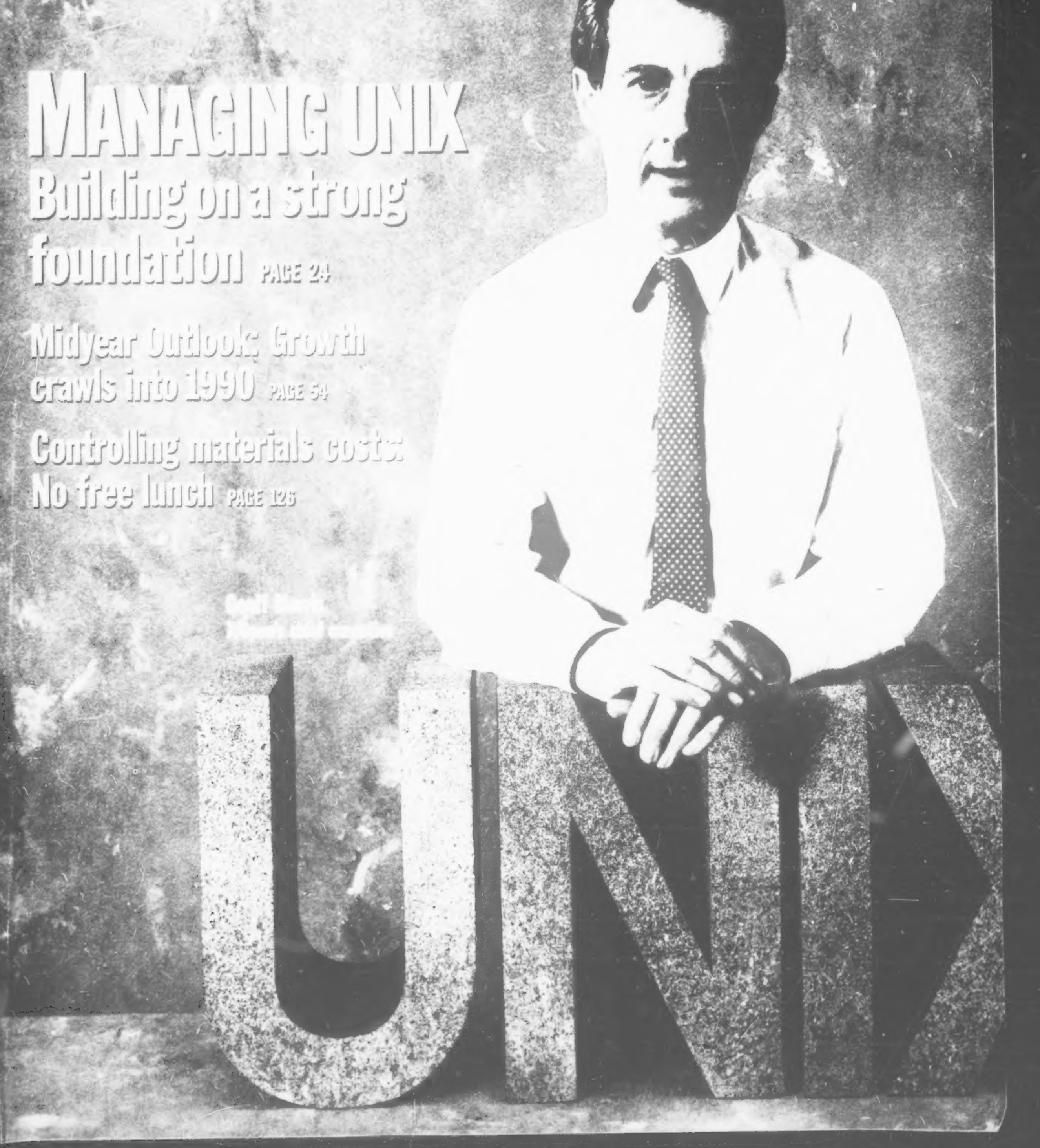
JUNE 26, 1989

MANAGING UNIX

Building on a strong foundation PAGE 24

Midyear Outlook: Growth crawls into 1990 PAGE 54

Controlling materials costs: No free lunch PAGE 126



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Electronic Business
FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE
VOL. 15, NO. 13 JUNE 26, 1989

PAGE 24 **X/Open's Morris: What will Unix look like in the future?**

COVER STORY/MANAGING RESOURCES

24 The Unix split: Divided they compete

For most of the 20 years since its creation, the Unix operating system has remained largely relegated to the technical world. But in recent months Unix has become one of the hottest — and most controversial — topics in the computer industry. The future direction of Unix as a standard has split vendors into two camps, each developing a competing version of the system. That leaves hardware manufacturers and software developers in a quandary about which direction to take.

BUSINESS TRENDS

17 Chip makers chase TI in rapidly growing DSP market

TI's pioneering work with users has opened up a market teeming with activity — digital signal processors. From fax machines to speech processing, DSP chips are cutting a wide swath through a number of new areas, and rivals want more of the action.

COVER STORY/MARKET PERSPECTIVES

24 The Unix split: Divided they compete

As Unix comes out of the closet, disputes over control are tearing vendors apart. There are those who believe that a divided Unix world will hurt computer product vendors and users alike. Is there light at the end of the tunnel?

Motif winning GUI battle

Just as the graphical user interface (GUI) is the most visible aspect of computing, the race within the Unix market to establish a standard GUI has become the most visible skirmish within the larger Unix schism.

X/Open plays the role of peacemaker

Where confusion and incompatibility now reign, the X/Open consortium offers what may be the best hope for bringing sanity and standards to the computer industry.

The outlook for Unix

Sales of Unix-based systems are expected to grow from last year's $8.2 billion to $26.4 billion by 1993, a compound annual growth rate of 26%. A big future question is how well Unix will compete against OS/2.

STRATEGIES

37 EDA: Marketing moves into the driver's seat

A maturing market is forcing the major vendors in the electronic design automation industry to focus strongly on marketing demands. Resulting are an increased awareness of customer needs and increased customer involvement in the product development cycle.

MIDYEAR OUTLOOK

54 Stagflation, here we come: U.S. growth slows into 1990

There is no doubt the economy is slowing down and will continue into 1990. But while forecasts of recession have filled the headlines, the broader consensus is for a soft landing — as long as the Fed does not pull any fast ones and the U.S. government does not go on a protectionist rampage. The pattern will be mirrored in the electronics sector, forecast to slow by 5.6% this year and 2.3% in 1990.

58 What electronics industry economists foresee

ELECTRONIC BUSINESS elicits forecasts from leading economists at seven large U.S. electronics companies. They offer ideas about what electronics companies should be doing to survive the downturn.

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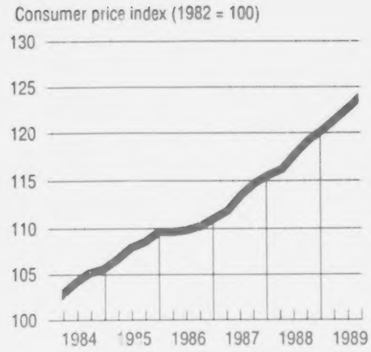
PAGE 11 Rapro Technology's Charles Chen: Depositing silicon layers one crystal thick



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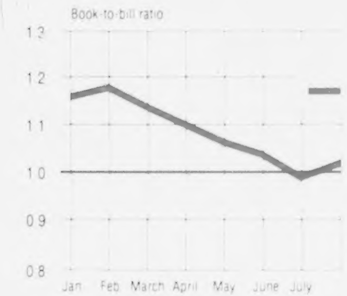

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70 **Semiconductors**
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EUROPE BUSINESS

111 **100-year-old Nokia experiences fast-growth pains**

Like other European companies, Nokia is positioning itself for the removal of European trade barriers in 1992. It is doing so with an acquisition-bent strategy that has it shifting out of its traditional core industries and into electronics. In the process, sales have shot up and profits down.

MANAGING RESOURCES

126 **Why systems makers have to work off materials costs**

The free ride in cost containment is over. In the past decade, U.S. electronics manufacturers lowered prices, increased volumes and improved profits, all because their product costs enjoyed a natural rapid decline. But no more. Future advances will require aggressively managed material costs and manufacturing overhead.

Bose heeds lessons on costs from the Japanese

Xerox avoids costs before they occur

BUSINESS BAROMETER

167 **Industry figures and forecasts**

Annual figures, by industry segment, for shipments, new orders, inventory and production.

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Whether distributors like it or not, the economic business cycle does have an impact on their sales.

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We the people

A magazine is truly the sum of many parts — the editorial and art staffs, the production people, the advertising salespersons and the circulation personnel. Many people contribute to the magazine you are now reading. Some people get bylines and achieve a degree of fame, if not fortune. Others are largely unsung heroes, whose names may appear on the masthead to the left of this column.

Many of the folks listed on the left are also in the photo below, a picture taken in April following one of our rare meetings of the entire editorial staff. A few people are missing —Bill Cooke, our art director who was busy art directing a cover at the time, and Bruce Rayner, our man in Southern California who was on his way back to a looming deadline. We're also missing Mike Leibowitz, an associate editor; and Carla Aguilar Leeder, our associate art director; who both joined the staff after the photo was taken.

The editorial staff

Which reminds me that the editorial and art staffs of magazines tend to be wonderfully fluid. Not only are good, creative people hard to find, but they are equally hard to keep. So with this issue, we say goodbye to two of the faces our picture — Anne Knowles, a senior editor who started with ELECTRONIC BUSINESS five years ago as an editorial assistant, and Sherri Hartlen, our current editorial assistant who has succumbed to the lure of working in downtown Boston. We'll miss them both.

By the time you read this column, we'll probably have people sitting in the cubicles that once housed Anne and Sherri. It's entirely possible that we might have some openings, too. If you have a journalistic background and enjoy writing about the business of electronics, drop me a line with a resume and a few of your best clips. You just could become one of our people.

Whither electronics

Our research tells us that our readers value ELECTRONIC BUSINESS for our forecasts. In this issue, we present our Midyear Outlook which combines the efforts of several editors and several researchers with Cahners Economics, notably Elizabeth Baatz, Madeline Franchi and Julie Handelman. It's truly a team effort by many of the people who make ELECTRONIC BUSINESS informative reading. If you find the outlooks useful, write me a note — I'd like to pass your comments on to Liz, Maddy and Julie.

JEFF BAIRSTOW, executive editor

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BPA ABP

Chip makers chase TI in rapidly growing DSP market

As applications mushroom, prices drop and volumes soar for DSPs. But training and support are still key factors

For Texas Instruments Inc., the original developer and leading evangelist for digital signal processors, being on top of the market with an estimated 63% share has its problems. The higher you are, the better target you make. Thanks to its "missionary marketing" in DSPs, TI has created a tempting target in single-chip solutions. Although the market was a relatively modest $222 million last year, according to market research firm Forward Concepts Inc., of Tempe, Ariz., it is growing at a compound annual growth rate of more than 40%.

So, suddenly, competitors have rushed in, looking for a piece of the action. AT&T, Fujitsu Microelectronics Inc., Motorola Inc. and NEC Corp., to name a few, are joining the fray for single-chip DSP design wins. Although Dallas-based TI is hardly sitting by complacently, with over 50% more of the market than all its nearest competitors combined, it is unlikely to fall from the top for some time to come. But TI's early pioneering work with users has opened up a market teeming with activity.

From facsimile machines to speech processing and motor control, DSP chips are cutting a wide swath through a number of new areas, far from the traditional military or telecommunications applications. For example, General Motors Corp. is expected to replace the spring-based suspensions in 1990 Corvettes with adaptive electronic suspension systems based on four (one per wheel) 32-bit general-purpose digital signal processors driving hydraulic controls. The system is currently under development by Britain's Lotus Engineering, a recent GM acquisition. Complex automotive electronics could open up a huge market for DSPs, say some observers.

What makes DSPs so valuable to industrial and electronic systems designers is their single-minded focus on high-speed mathematical computations. Even the highly touted RISC microprocessors slow down as they struggle to crunch numbers in real-time. But DSPs can do a multiplication-and-add operation in a single clock-cycle, making them ideal for analog-digital conversions and real-time applications.

The early bird

TI, which began DSP development in 1979, had three things going for it that earlier makers lacked. First, TI was able to manufacture significantly high-speed parts — with clock cycles as fast as 200 nanoseconds — rapid enough to support applications that couldn't be served by regular microprocessors. Second, TI entered the market just as PCs were being widely adopted by engineers as inexpensive design platforms. And third, according to TI, the company knew it would have to educate the new market.

A few years ago, most engineering schools taught electronic engineering students how to design with standard microprocessors, but virtually no one offered classes in digital signal processing design. Today, largely through TI's efforts, the discipline of DSP design is taught at 200 universities.

TI's evangelism worked, securing it an estimated $140 million in sales last year, according to Forward Concepts president William Strauss. "We made a serious financial commitment with the long-term goal of turning [DSPs] into a profitable business," a TI spokesman explains. The DSP line is now "very profitable and we have been reinvesting the profits for many years," TI says. Michael Haimes, TI's DSP department manager, says the company today has about 10,000 general-purpose DSP customers who log in about 1,000 calls per month to TI's hotline.

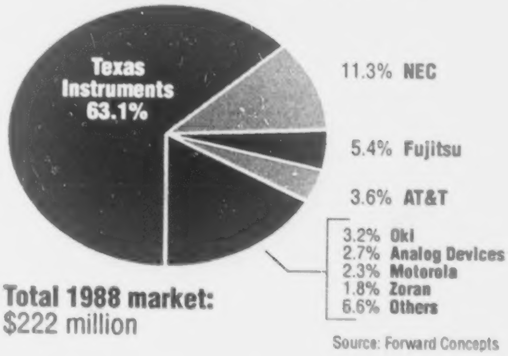
Friendly competition

NEC, which entered the merchant market the same year as TI, but without the same missionary fervor, achieved an 11% market share last year, according to Forward Concepts. Following NEC are Fujitsu Ltd. with 5% and AT&T with 4%. And although these companies are investing heavily in DSPs, Strauss contends that TI has a head start that may be hard to beat. "There is a long time between design win and volume production," he says. "It's at least two years. That's kind of a buffer zone. To catch up to TI, a company is going to have to spend four times its annual volume to reach the same level of sales," Strauss contends.

NEC, like AT&T, began its market focus on telecommunications applications, an area for which both companies have large captive markets, according to NEC's George Wang, DSP product line manager. "DSP is a major focus for

1988 digital signal processor market

Worldwide sales of general purpose DSPs



Source: Forward Concepts

NEC," says Wang. But, he admits, the company's level of support, while "superior," can't match TI's. NEC is banking on its status as the world's largest supplier of semiconductors and its loyal customers to build market share.

Fujitsu admits it doesn't have the facilities to offer the widespread customer support offered by TI. According to Paul McGuire, product marketing engineer for Fujitsu's DSPs, the company is depending on developers who already have experience in digital signal processing to increase its market share.

"TI is spread so thin they lose contact with their customers," McGuire contends. "Our philosophy is to work one-to-one with engineering, to develop that relationship, and get repeat business. We'll leave the training to TI, and deal with the DSP user," says McGuire. Fujitsu hopes its newest 32-bit DSP, which is the first to include support for the IEEE-754 standard for floating-point math operations on silicon (other makers rely on software), will attract users who need ICs that are compatible with existing software databases, many of which use the IEEE standard.

Price wars

Price, the major DSP makers agree, will be a key factor in growing the market by making new applications economically viable. As the largest single consumer of DSP chips in the United States, AT&T is still expanding its merchant capacity. Strauss estimates that its merchant sales ($10 million to $12 million this year), are only one-tenth its internal usage. AT&T is competing on price. AT&T's low-end 32-bit DSP is now priced at less than $50 each, while other companies' chips run well over $100 each.

AT&T isn't attempting to buy market share with its stripped-down prices, says Charlie Mera, technical support engineer for DSP, but the company can afford to offer low prices because AT&T's architecture allows the circuits to be about half the size of its competitors.' And, AT&T can leverage from a process technology that is driven by a large base of captive applications.

The AT&T 32-bit DSP, for example, is now priced competitively with the math coprocessors that are used in desktop computers. "You can sell a DSP-based add-in card for less than $1,000," says Mera, "while it costs you more than $500 for a single 80387 math coprocessor IC." And, the DSP card does math operation in a single cycle, compared with about 20 cycles for the 80387 solution, according to Mera.

TI lags behind AT&T in price. It's not projecting $100 prices for its 32-bit DSPs until next year sometime, says a spokesman. But TI's sell is the total system cost, says Haimes. This means the cost of not only the DSP chip, but the cost of peripherals and memory. TI's most recent introduction, the 320C5X, reportedly features the largest amount of on-chip memory of any DSP, saving users money for memory, Haimes stresses.

SASHA LEWIS

What people think about your company may have more to do with your success in the marketplace than anything else.

Electronic Business

The outlook for Unix

Sales of Unix-based systems are expected to grow from last year's $8.2 billion to $26.4 billion by 1993, a compound annual growth rate of 26%, according to the International Data Corp. market research firm in Framingham, Mass.

"If you stop looking at just PCs and look at the whole computer industry, Unix is just outgrowing everything else," says IDC analyst David Card.

Despite earlier fears that the schism within the Unix world would slow its acceptance among users, most vendors and industry watchers now believe that the imbroglio over the operating system's future, and the resulting publicity, has actually increased its growth rate.

"If no one is fighting over it, it's not important," concludes Michael Tilson, president of HCR Corp., a Toronto-based developer of Unix system software. He says that the born-again interest in Unix shown by IBM and Digital Equipment Corp. has also "caused people to sit up and take notice."

Unix, nevertheless, has its skeptics. A recent report from the Boston-based Aberdeen Group consulting firm concludes that Unix has failed to live up to its promise to provide users with hardware independence and that the "Unix Tower of Babel" will not disappear this year or next.

A big question is how well Unix will compete against OS/2, the successor to the ubiquitous DOS.

This year some 490,000 Unix-based CPUs will be shipped, compared with 2.9 million CPUs running OS/2, according to the Dataquest Inc. market research firm in San Jose. By 1992, shipments of CPUs running Unix will increase to 960,000, but sales of OS/2-based CPUs will grow to 12 million.

Unix, however, is a multiuser operating system while OS/2 is single-user. Last October, AT&T shipped its millionth Unix license and Novon Research Group research director Brian Boyle estimates that adds up to some 7.5 million Unix users.

Dataquest concludes that both Unix and OS/2 "will be winners in the fight for control of the desktop operating system."

Another major factor in the future of Unix is the amount of support it will receive from IBM. Although Big Blue has been sinking vast resources into developing Unix-based products, the company appears to be putting more emphasis on OS/2 for its desktop systems. Last month's introduction of the Officevision family of software — based on OS/2 — was seen as another step in that direction.

The Aberdeen study concludes that Unix could catch on more quickly if "shrink-wrap" software, portable applications sold through dealer and retail channels, becomes more available. But in a chicken-and-egg scenario, observers say Unix must become a standard before such software becomes more prevalent.

"As soon as there is a certain amount of standardization, then shrink-wrap becomes more and more a possibility," says Raymond Anderson, president of IXI Ltd., a Cambridge, England, developer of a desktop manager graphical interface.

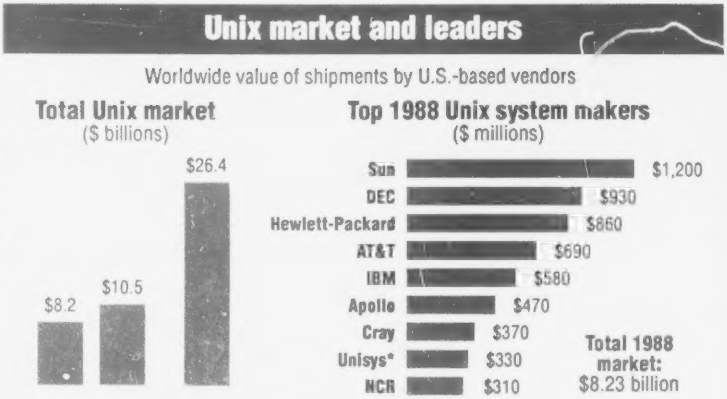
But Anderson urges caution for software developers looking to cash in on an expected Unix market. "Anyone in this business has to have a reasonable amount of conservatism in their view of the long term," he says, adding that vendors in the past have "had their fingers burned" when growth projections exceeded reality.

James Barclay, DEC software technology consultant, predicts that by 2010, the only operating systems will be Unix, IBM's MVS, DEC's VMS, and OS/2 or DOS on the desktop, although some add Apple Computer Inc.'s MacOS to the list.

While there have been attempts to create new operating systems, such as the Japanese effort to develop the Tron operating system, few industry watchers expect anything to replace Unix any time soon.

"It's very difficult for me to believe that someone is going to sit down and write another operating system from scratch," concludes J. Thomas West, systems development division senior vice president at Data General Corp.

Boyle agrees that the growth of Unix could slow. "To go from 1% of the [computer] market to 21% of the market is a lot easier than to go from 21% to 41%." Although he believes that Unix will account for the largest number of users of any operating system, he still does not see it exceeding one-third of all computer users. ☐


Unix market and leaders

Worldwide value of shipments by U.S.-based vendors

Source: International Data Corp.

* Includes Convergent, does not include OEM products

EDA: Marketing moves into the driver's seat

EDA's growing pains cause vendors to look to marketing as a way to respond to customer demands. There are major benefits to both buyers and sellers

BY TONY GREENE

A maturing market is forcing the major vendors in the electronic design automation industry to focus strongly on marketing demands. The results are an increasing awareness of customer needs and more involvement of customers in the product development cycle.

A design environment that is at once more extensive and more complex is causing marketing to replace technology as the driving force behind EDA. Customer demand for integrated systems is a major trend. "When you start talking about horizontal and vertical integration, marketing starts having a great effect. You have to win the hearts and minds of customers and you do that with marketing," says Charles M. Foundyller, president of Daratech Inc., a Cambridge, Massachusetts-based market research firm. This increased focus on marketing is giving vendors new insight into product development and a chance to solidify and enlarge their installed base.

Difficult transition

For many companies the transition to being market driven may not be easy. "Many of these companies were engineering driven," notes Bruce Bourbon, vice president for marketing for Cadence Design Systems Inc. of San Jose. Still, almost all of the major players have recognized the importance of marketing and are positioning their strategies to become more responsive to the market.

The one company that always had a marketing focus is Mentor Graphics Corp. of Beaverton, Ore., the industry leader with 1988 sales of $301 million. With its strongly marketing-based strategy, Mentor has achieved a dominant position in the EDA world, controlling a 24.2% share of the $1.2 billion in revenue generated last year by U.S. vendors worldwide.

Mentor intends to continue on the course that took the company to number one. "I don't think there is any question that marketing is important in EDA. [Marketing] is just as important to us as the quality of the products," says Mentor's group vice president, Frank Costa. "Internally, marketing has equal weight with technology. We want to be a market-driven company." About 10% of Mentor employees work in marketing.

A strong marketing influence shows clearly in Mentor's product development process. The formalized, eight-step process has been designed to involve the customer in at least half of the stages. This kind of formalized process is a good example of the methods being employed industry-wide to meet customer needs.

Mentor's Frank Costa: "Marketing is just as important to us as the quality of the products"

This is how Mentor's design process works:

- 1. Marketing writes a requirements document for a new product or an enhancement of an existing product.
- 2. A project team composed of people from marketing, engineering, service, training and quality assurance is assembled.
- 3. Customers are brought in and acquainted with the idea; their input is incorporated.
- 4. A functional specification is written. The product will be developed from this specification.
- 5. The customer is brought in to comment on the specification.
- 6. Development starts. At this point engineers start generating code.
- 7. Alpha testing is done. Customers are brought in to use the product with development engineers.
- 8. Beta testing is done, usually at customer sites.

The benefits of listening to customers are clear. For example, during recent alpha testing on Mentor's Quickgrade product, a high-speed fault grading tool, a major customer suggested that the information gathered for the fault grading would also be useful for logic design. The trick for Mentor was to get the information to the engineer in an easy-to-use format. Mentor managed to incorporate the change in the beta release of the product. The enhancement to Quickgrade has opened up a new market channel for the product. What's more, the customer who made the suggestion has decided to buy several hundred copies of the product because of the new feature alone.

This process of product development — marketing initiated, with intense customer input — has been one of the keys to Mentor's success. Another key to Mentor's winning strategy is a company-wide attitude. "Everybody at Mentor thinks of themselves as marketing people," says Costa.

The importance of marketing has not escaped Mentor's competitors. Strategies that reflect the growing need to be responsive to customer needs are being implemented throughout the industry. Companies such as Daisy/Cadnetix, Valid Logic Systems and Cadence have all perceived a need for a market-driven strategy. "In the past they [EDA vendors] made tools we could use but it was their vision. There has definitely been a change: products are more integrated and on more platforms so we aren't held hostage by the vendor. These changes all came out of customer needs," says Dave Evans, manager of integrated electronic design systems for General Dynamics Corp. in San Diego.

But that doesn't mean that customers are completely satisfied. "The major EDA vendors are still focused on the short term. They have a weakness in the area of looking at where I need to be in five years," says Evans.

From Valid Logic Systems Inc.'s perspective, the need to build sales into big accounts is one of the major drivers for a marketing-based strategy. "From an industry standpoint, [marketing] is important because there are still quite a few folks who are decision makers in large companies that have to buy our product. A lot of the reason for marketing is to expose them to what CAE can do," says Robert Moore, vice president for sales of the San Jose-based company. Valid spends approximately 6% of sales revenue on marketing.

Valid's Robert Moore: "Marketing is the keeper of the balance between engineering and customer needs"

Historically, Valid was an engineering driven company where marketing received finished products but had limited input into the development process. Those days are gone. "Marketing is leading the charge saying, 'Here are the areas we need to go address,' " says Valid's director of product marketing Richard Albright. This is where Valid touches base with its customers' needs and views on the direction of product development. In the last year Valid has initiated a seven step product development cycle that starts in marketing and proceeds through alpha and beta testing. "Marketing is the keeper of the balance between engineering and customer needs," says Moore.

One of the major developments of Valid's recent marketing bent is the concept of network licensed software. Traditionally, EDA software has been nodally locked. This meant that each workstation was dedicated to a specific function and was resource-shared by engineers who had to move from station to station to complete a design. Because the industry has shifted to standard hardware platforms that are frequently networked, customers want to run multiple software applications on a workstation. Another factor fueling this desire is the ever-decreasing cost of workstations and the increasing feasibility of putting a workstation on every engineer's desk.

Driven by these factors, Valid developed Access, a product that allows network access to their design tools. This allows customers to buy the number and type of tools they need based on projected usage. "Valid was kind of forced into [the network access strategy] because they support DEC and Sun. Both are heavily networked," says Daratech's Foundyller.

Customer needs have also become a driving force at the recently merged Daisy/Cadnetix Inc. [Dazix], now the number two EDA vendor with 17.6% of the market. "We define product, hopefully by understanding the market's needs. To be successful you have to understand the market envi-

EDA vendors and customers learn the benefits of marketing

Benefits to the vendor

- Products developed in order to meet customer needs are easier to sell
- Markets for products are defined before the products are ready for sale
- Customers are more inclined to buy a product that they contributed to during development
- Potential customers are more aware of the capabilities of vendors and their products
- Marketing gives vendors a clearer definition of their products' strengths and weaknesses

Benefits to the customer

- Key customers know about and can be using products before initial release. This gives them a greater buy in on the product and increases vendor loyalty
- Customers are happier because they feel their needs are being actively considered
- Products can be tuned to the needs of the market and the installed base
- New ideas for use of the product arise that can open new market channels
- Customers have less room to complain that they are not getting what they want

ronment, the technical environment and the competitive environment," says O.B. Feltman, senior vice president for marketing for Dazix. The key to Dazix's strategy is a solutions approach. "Our mission statement is to be a solutions company, not a product company," says Feltman.

Selling solutions

When the focus shifts to selling solutions more than products, that leads to a different type of sale than has been traditional in the EDA market. "An increased percentage of our business is with large accounts," says Valid's Moore. This is the trend for all the major players in the EDA arena. Mentor has concentrated on the big account sales approach for several years. Valid and Dazix are rapidly tuning their marketing efforts toward big accounts.

Focusing on large accounts means making a significant investment over a longer period of time. For many in the EDA industry this is a change of perspective. "In the past most CAE companies have been driven by quarterly numbers," says Moore. Valid had roughly 20 sales of the million-dollar size in 1988. Mentor has seen the number of million-dollar sales rise from 12 in 1987 to 43 in 1988.

Large account sales mean more than longer sales cycles: they also mean a different approach to marketing. This shows up clearly in advertising and public relations. "We have a fairly narrow group of customers. Advertising is used to position the company in the market to try to communicate a global technology message," according to Cadence's Bourbon. Cadence is spending 5% to 7% of sales revenue on marketing. The major EDA vendors see advertising and public relations in today's environment as a way to position the company as a whole. With public relations and advertising being used to position the company with upper level management, direct mail and seminars are more precise methods of reaching the actual engineering user.

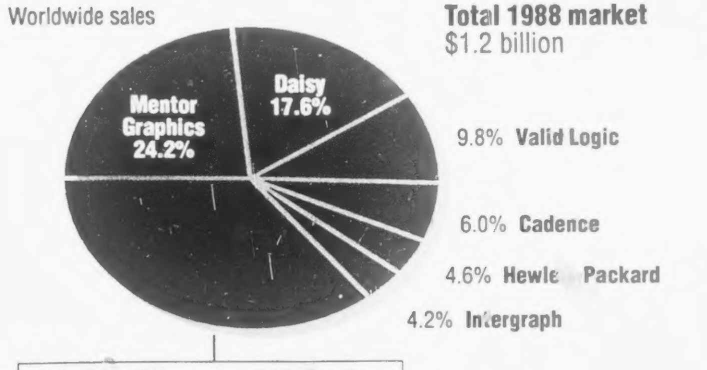
Cadence's Bruce Bourbon: Marketing gives everyone the feeling that they contributed

The smaller players in the EDA arena also recognize the importance of marketing. "It is how you decide what products you build. Marketing is the most important factor for anyone who is not the absolute market leader. For everyone who is not the market leader, marketing is a game of: what you are strong at, how can you distribute the product and what will the competition look like," says Joseph Lassiter, vice president of Teradyne Inc.'s Santa Clara, California-based EDA group. Teradyne's strategy relies on leveraging off a customer base that is already an EDA buyer from one of the major players. "We are typically selling into a DMV [Daisy/Mentor/Valid] environment rather than replacing them. We sell specific tools," says Lassiter. Teradyne sells simulation and test generation tools that are designed to be integrated into other design environments.

Gateway Design Automation Corp., of Lowell, Mass., is another small company that has recently emphasized marketing. "Even if it is a technical sell you still have to win the customers' mind. We had a session specifically on strategy to listen to the customer. You'd be surprised how much we learned," remarks Gateway's president and founder Prabhu Goel. One of the lessons learned by Gateway was that its customers wanted direct access to data structures in the Verilog product in order to integrate Gateway tools into a heterogenous design environment. In response to this, Gateway developed the Verilink product which gives the access needed. This will be used by customers who need to do mixed analog/digital simulation as well as ASIC suppliers who want to use Verilog with their ASIC design toolkit.

The things that can be learned from customers and the benefits that can be gained by learning them are essential to the growing importance of marketing in the EDA world. "Marketing is the process of creating products. It turns out that it is the process that is important. It ultimately gives everyone the feeling that they contributed. The process gives them the 'buy in,'" says Cadence's Bourbon. ☐

1988 EDA sales by U.S. vendors



Source: Daratech Inc.

Stagflation, here we come: U.S. growth slows into 1990

Brake time for the U.S. economy; electronics-sector growth is forecast to slow 5.6% this year and 2.3% in 1990 as inflation settles in at 6%

BY BRUCE C.P. RAYNER

There is no doubt that the economy is slowing down and will continue to slow into 1990. But while forecasts of recession have filled the headlines these past few months, the broader consensus is that a soft landing is more likely — as long as the Federal Reserve Board does not pull any fast ones and as long as the U.S. government does not go on a protectionist rampage.

Cahners Economics, the research arm of Cahners Publishing Co., expects no calamities in the next nine months. While the economy will head south this quarter as the Fed's tight money policy has the desired effect, it will rebound next quarter. (It takes two consecutive quarters of negative growth to qualify for a recession.)

Gross National Product, the total output of the U.S. economy, will average 2.47% growth for the year, Cahners predicts. This is slower than the 3.86% growth rate posted last year, but is faster than the 2.19% rate Cahners forecasts for 1990.

The pattern will be mirrored in the behavior of the electronics sector: Cahners forecasts that the U.S. electronics production index will sag from 112.4 for the first quarter of 1989 to 111.53 for the last quarter (based on a first-quarter 1987 base of 100), showing no improvement until midway through 1990.

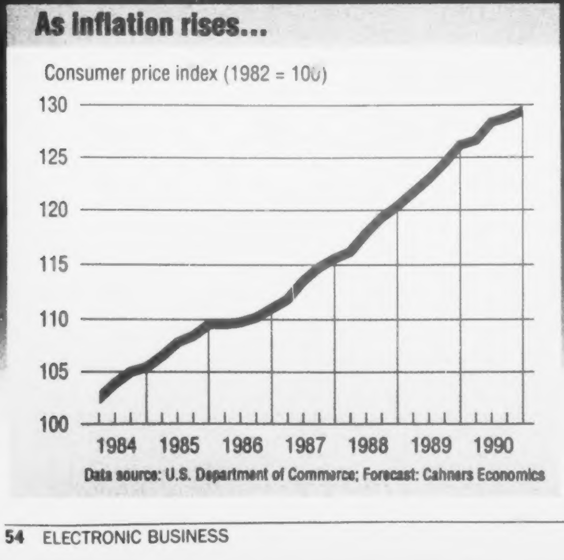
Others see the same coming. Henderson Ventures, an electronics forecasting firm in Los Altos, Calif., puts electronics at a 5.6% annual growth rate this year and only 2.3% next year.

And economists at the U.S. electronics industry's leading corporations are in accord. ELECTRONIC BUSINESS elicited the best projections from the economic gurus at: AT&T, Digital Equipment Corp., Hewlett-Packard Co., General Electric Co., 3M Co., Texas Instruments Inc. and Unisys Corp., and found their numbers amazingly consistent.

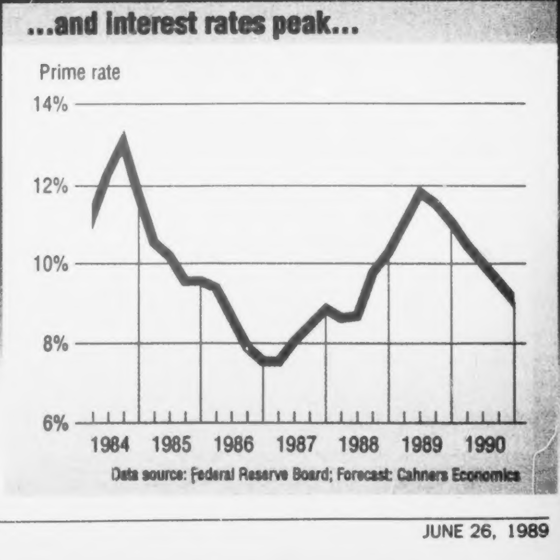
Like Cahners, most of those surveyed expect a soft landing, but a recession should not be ruled out, they say. The probability they assign to a recession hovers around 40%. Their consensus puts overall U.S. GNP growth in 1989 around 2.7%, dropping to around 1.75% in 1990. The low point will be the fourth quarter of 1989 or the first quarter of 1990.

Electronics executives share the somewhat sanguine vision of the future. They are seeing the slowdown but most expect it to be mild. Orders

The economy


As inflation rises...

Data source: U.S. Department of Commerce; Forecast: Cahners Economics


...and interest rates peak...

Data source: Federal Reserve Board; Forecast: Cahners Economics have been slowing for the last six months and sales are expected to be sluggish through early 1990. Fred Cox, president and CEO of $150 million Emulex Corp. sums it up well: "I'm not bullish but I'm not pessimistic either. I haven't seen enough signs to go into a contingency plan."

Economists' recommendations for dealing with the slowdown range from tightening cost control to targeting foreign growth markets. A common theme is the need to continue investment in productivity-enhancing equipment both as a way to improve competitiveness and as a way to fight rising labor costs. But above all, "conservative planning is the order of the day," insists Richard O'Brien, corporate economist at Hewlett-Packard.

Stagflation

While the recession issue can be debated to death, the real long-term worry is "stagflation." That is, economic stagnation combined with inflation. The reason is that cost-push inflation has taken hold and is hard to purge. While 1970s style double-digit inflation is not expected, economists predict it will hover around 6% for the next couple of years. Anything over 4% is too high, say both academics and policy makers.

But there is little that can be done to force the economy into line. The problem is weak fundamentals. "The financial system is fragile, the manufacturing sector is more leveraged, the trade and budget deficits are infinitely more worrisome than they were 10 years ago and a policy of monetary stringency puts all that at greater risk," says Everett Ehrlich, vice president for economic analysis at Unisys.

If interest rates go too high, the system could collapse. Alternatively, as the economy cools, lower interest rates become a mixed blessing. They are good for the domestic economy but bad for the budget deficit. They also will lead to a lower dollar, which is good for exports but increases direct foreign investment in the United States.

Economists are predicting interest rates to drop over the next year

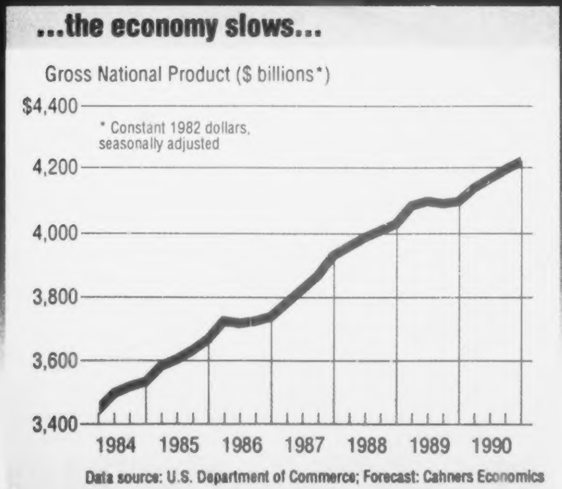
Assuming nothing too unexpected happens, economists are predicting interest rates to drop over the next year. Data Resources Inc. (DRI) puts the prime rate at 9.5% in 1990; down from a high of 11.35% this year.

As a result, the dollar will also fall by maybe 10% and inflation will stabilize between 5.5% and 6%. Coupled with less than 2% GNP growth, the economy looks like it is catching a low-grade variety of the stagflation virus. According to Ehrlich at Unisys, stagflation will hang around "until the U.S. addresses its budget and trade imbalances."

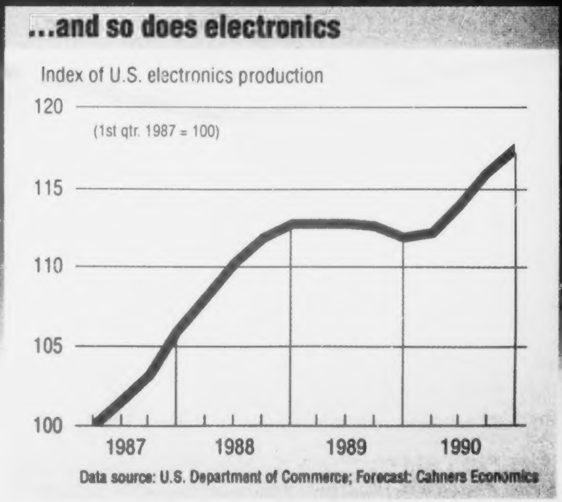
Electronics cycles in synch

For the U.S. electronics industry — at around $250 billion in production a year, it's the largest U.S. manufacturing segment, bigger than either automobiles or chemicals — this has considerable implications, especially as the industry matures. It is taking on more of the characteristics of a traditional capital goods market with less pronounced growth cycles. Consequently, says DRI's director of forecasting Christopher Caton, "the electronics industry has become more integrated and will follow the business cycle of the rest of the macroeconomy."

Generally speaking, capital goods spending in the United States peaked in 1988, driven largely by a weaker dollar, and has been slowing ever since. James Whittaker, chief economist at DEC, expects capital spending to be weak in 1989 and even weaker in 1990 as the economy slows. Spending on computers in the United States will increase by between 5% and 8% in 1989, down from 11% growth in 1988, and will drop


...the economy slows...

Data source: U.S. Department of Commerce; Forecast: Cahners Economics


...and so does electronics

Data source: U.S. Department of Commerce; Forecast: Cahners Economics to increases of between 1% and 3% in 1990, he says.

Of course, most electronics companies consider themselves the exception to the rule. Either they are in a high growth segment divorced from the rest of the economy or their product has a life cycle all its own. Even so, macroeconomic effects will creep in.

Take Hilevel Technology Inc., a $10 million-plus ASIC design and verification tools company. Although it is tied to its customers' design starts, which are for the most part independent of economic fluctuations, it is feeling the macroeconomic pinch. The gestation period of orders, usually a few weeks, has stretched out to three to six months. "It's a reflection of uncertainty," says Norbert Laengrich, Hilevel's vice president for marketing.

Still, electronics is better insulated than most other industries from the vagaries of economic ups and downs. Computer sales will still be driven in part by technological improvements that push the cost of computational power down. Case in point is the workstation market, slated to grow at above 40% no matter what happens to the economy. Also, telecommunications looks healthier than average.

There are other exceptions, too. Capital investments for the purpose of cost control and productivity improvement are more likely to be made during a recession than capital investment for the sake of expansion. As competitive pressures increase between the Far East, the United States and Europe, a growing percentage of capital investments in electronic equipment is being made for these reasons, economists say.

One way to grow through a slowdown is to target growth markets. "Contractions and expansions are never synchronized, there is always an economy somewhere that is taking off," comments Alan Reynolds, chief economist at Polyconomics Inc., a supply side economic consulting firm in Morristown, N.J.

Suggestions for dealing with the slowdown range from tightening costs to targeting foreign growth

Vladi Cato, chief economist at Texas Instruments Inc., agrees: "The global mindset is an absolute must in this day and age." If you are not already exporting, now is the time to get started, he says.

Europe is undergoing structural change in preparation for the end of 1992 when intra-European trade barriers will come down. This should spur sales. Likewise, Japan's economic growth is expected to outpace the United States' in the next few years. Says a Tektronix Inc. spokesperson: "We think most of our success will be driven by having the right products in the right markets." For the most part, that means Europe and the Far East.

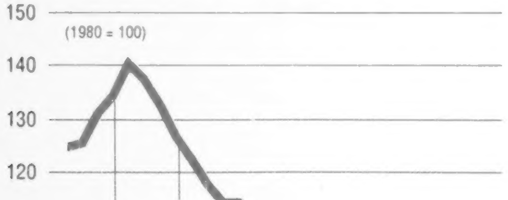
But there is a protectionism cloud brewing on the export horizon. The Bush administration's Trade Representative, Carla Hills, has compiled a list of 34 of America's worst trade offenders and is devising a scheme of how to deal with them. Of particular concern to Hills is the lack of access to Japan's telecommunications markets afforded U.S. vendors.

Critics warn that retaliation could plunge the world into deep recession. "I think one of the major risks we face over the next few years is the risk of increased protectionism," warns TI's Cato.

Even Michael Boskin, chairman of the President's Council of Economic Advisors, has warned of a trade war and resulting stagnation in the world economy if the U.S. retaliates against its trading partners. Boskin's concern has historical precedence. It was the Smoot-Hawley Tariff Act, a piece of protectionist legislation that helped tip the United States into the Great Depression. ☐

Value of the dollar

Index of the dollar value against 16 trading partners



Data source: Atlanta Federal Reserve Board; Forecast: Cahners Economics

Electronics output by segment

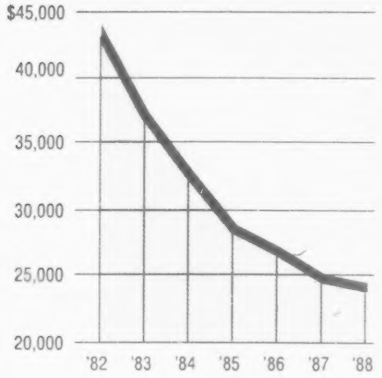
Percentage growth in current dollars

	1987	1988	1989	1990
Communications	5.0%	7.2%	5.8%	4.2%
Computer & office	6.5%	10.9%	7.7%	1.7%
Industrial & instruments	4.3%	14.3%	8.1%	3.9%
Commercial subtotal	**5.6%**	**10.9%**	**7.4%**	**2.9%**
Military	**2.6%**	**2.9%**	**1.4%**	**2.5%**
Consumer	**-1.8%**	**6.8%**	**3.1%**	**-4.5%**
Total	**4.2%**	**8.5%**	**5.6%**	**2.3%**

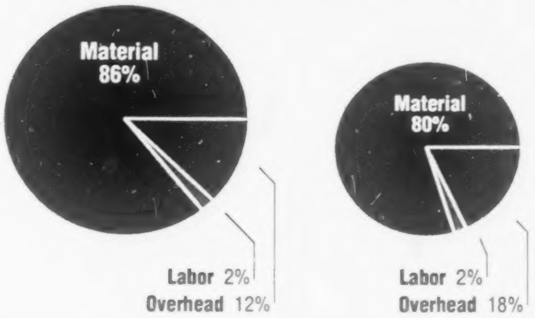
Data source: Henderson Ventures

Electronics industry cost index

- Since 1982, the composite product cost has decreased by 46%



- Even though materials represent the highest percentage of product cost, the opportunities for controllable cost reductions are decreasing.



Total 1982 product cost: $43,755

Total 1988 product cost: $23,689

Material	**1982**	**1984**	**1986**	**1988**
• Processor/logic	$17,221	$11,338	$10,742	$9,960
• Memory	7,220	4,758	1,560	1,509
• Power, cabinet, etc.	4,160	4,668	4,859	5,432
• Peripherals	9,160	5,969	3,682	1,981
Subtotal	**$37,761**	**$26,733**	**$20,843**	**$18,882**
Labor				
• Total dollars	**$750**	**$536**	**$477**	**$412**
• Hours	120	175	60	48
• Dollars per hour	$6.25	$7.15	$7.95	$8.59
Overhead				
• Material overhead	$3,744	$3,526	$3,209	$2,625
• Manufacturing overhead	1,500	1,688	1,869	1,770
Subtotal	**$5,244**	**$5,214**	**$5,078**	**$4,395**
Total product cost	**$43,755**	**$32,483**	**$26,398**	**$23,689**

- The bulk of the decline in material costs came from IC technology advances. Low-technology components, such as power supplies, cabinetry and packaging, are becoming an increasingly important area for cost reductions.
- Despite higher labor rates, productivity gains still led to reduced total labor costs. But labor cost reductions may soon reach a limit.
- Manufacturing efficiencies were offset by shrinking product life cycles and increased product complexity. Still, reducing overhead costs represents the best opportunity for cost reductions.

Source: Pittiglio, Rabin, Todd & McGrath

How the 1989 cost study was prepared

This study creates the electronics industry's version of a Consumer Market Basket Index. It provides a perspective on product cost trends by analyzing cost changes for a typical "composite product" using actual data for the years 1982-1987 and estimates for 1988. This approach measures the cost of supplying a product with fixed functionality using currently available technology.

One caveat: our methodology doesn't let the composite product improve in functionality the way acutal products do. In the "real world," our 1982 composite product would likely be outdated by 1988.

The composite product selected for this analysis has a cost-structure typical of product produced by many electronics manufacturers. It represents a systems product consisting of a 32-bit central processor with two megabytes of main memory. The system is configured in a one-bay rack with power supply. It includes 100 megabytes of disk storage, two terminals and a printer.

Although specific input and output devices, as well as software, will vary, the cost structure is consistent with many industry segment products. Examples of these products include CAD/CAM systems, minicomputers, automatic test equipment and intelligent workstations.

To quantify the change in the composite product's cost, PRTM created a representative product structure made up of nine modules and three peripherals. It then measured changes in the cost of the peripherals plus a dozen underlying material commodities and the effect of productivity gains in manufacturing processes and overhead operations. Where technology has shifted over the period of the study — the size of DRAM chips, for example — PRTM used average costs weighted by industry-wide mix of shipments.

PRTM obtained the data from Dataquest Inc., the Bureau of Labor Statistics, PRTM's proprietary benchmarking studies and its client base. ☐

Industry figures and forecasts

Electronic components

(SIC 367)	1987	1988	1989	1990
New orders ($ billions)	$48.56	$54.76	$52.09	$58.77
Shipments ($ billions)	$47.15	$54.70	$54.95	$58.46
Inventory/shipment ratio	1.76	1.83	2.01	1.80
Production index (1977=100)	250.2	278.9	278.1	290.4

Electronic component leadtimes

Weeks from order to delivery	1987	1988	1989	1990
Active components	8.7	7.3	6.5	7.0
Integrated circuits	7.6	4.5	5.4	6.5
Memory circuits	9.6	9.7	7.1	7.6
Microprocessor ICs	8.6	8.9	7.4	7.5
Passive components	6.2	5.0	5.4	5.7
Capacitors	6.9	5.3	5.5	6.3
Connectors	7.2	5.2	6.4	6.7
Printed circuit boards	5.9	5.5	5.4	5.5

Computers and office equipment

(SIC 357)	1987	1988	1989	1990
New orders ($ billions)	$60.69	$67.28	$66.89	$67.05
Shipments ($ billions)	$61.18	$67.76	$67.93	$68.44
Inventory/shipment ratio	2.07	2.12	2.16	1.92
Production index (1977=100)	282.7	315.3	324.1	329.9

Communication equipment

(SIC 366)	1987	1988	1989	1990
New orders ($ billions)	$70.71	$72.96	$71.06	$74.68
Shipments ($ billions)	$70.63	$74.24	$74.97	$75.86
Inventory/shipment ratio	2.63	2.36	2.55	2.53
Production index (1977=100)	220.9	219.0	212.9	213.9

Instruments and controls

(SIC 381-4)	1987	1988	1989	1990
New orders ($ billions)	$45.60	$49.93	$51.19	$53.48
Shipments ($ billions)	$44.66	$48.91	$51.15	$52.76
Inventory/shipment ratio	2.44	2.41	2.40	2.37
Production index (1977=100)	172.0	185.0	195.7	201.2
ATE sales index (1Q 1976=100)	660.6	827.6	867.1	887.1

Consumer electronics

(SIC 365)	1987	1988	1989	1990
Shipments ($ billions)	$11.47	$11.45	$12.29	$13.10
Production index (1977=100)	155.2	155.5	159.0	167.1
Color TV sales (millions of units)	19.33	20.22	22.53	24.00
VCR sales (millions of units)	13.31	12.79	12.67	12.62

Semiconductors

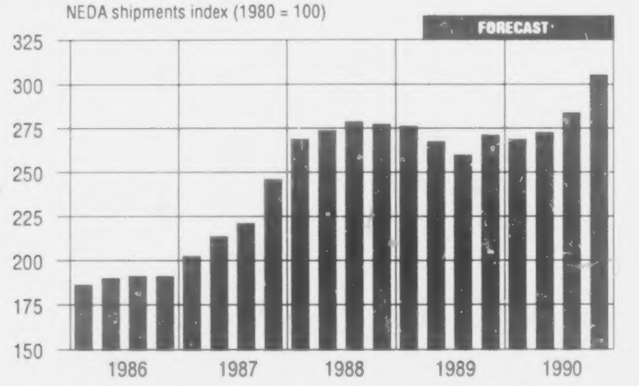
North American market	1987	1988	1989	1990
IC shipments ($ billions)	$8.61	$11.51	$12.58	$13.25
Discrete shipments ($ billions)	$1.65	$1.91	$1.81	$1.92
Total semiconductor shipments ($ billions)	$10.23	$13.42	$14.39	$15.17
Book-to-bill ratio	1.14	0.98	1.01	1.13

Defense

	1987	1988	1989	1990
Defense & space production (1977=100)	188.8	185.9	175.6	165.3
Aircraft & parts production (1977=100)	168.5	168.0	167.6	169.2
Aircraft & parts shipments ($ billions)	$103.4	$107.7	$107.5	$106.7

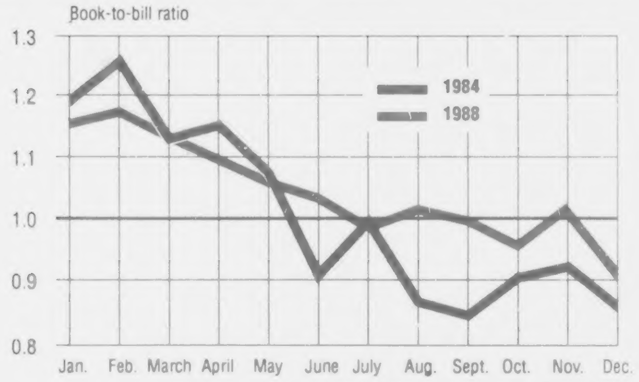
Compiled by Julie Handelman, Cahners Economics

Expect distributor shipments to slip only a bit...



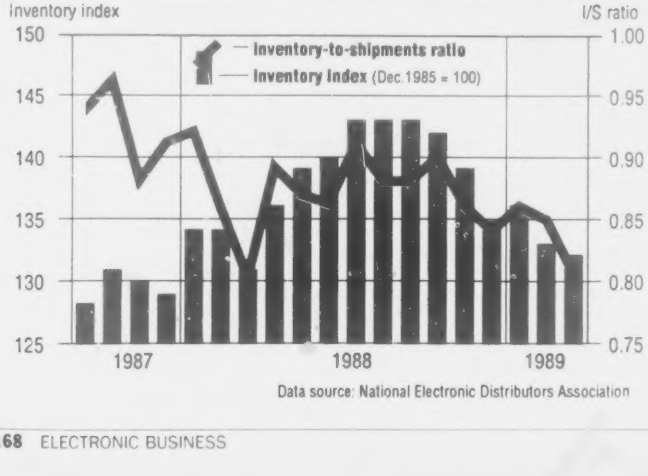
Data source: National Electronic Distributors Association; Forecast: Cahners Economics

...since the book-to-bill ratio has been healthier...



Data source: National Electronic Distributors Association

...and inventory remains under control



Data source: National Electronic Distributors Association

A bearable downturn for distributors this year

Whether distributors like it or not, the economic business cycle does have an impact on their sales. Unfortunately, sales in 1989 are following the downward portion of the business cycle curve now.

According to the National Electronic Distributors Association (NEDA), shipments rose 2.6% in the first quarter of 1989 above first-quarter 1988 levels. March shipments actually fell 0.8% below year-ago levels. That, by the way, was the first monthly decline from the year-ago level since January 1986.

News from NEDA on the orders front clearly show the economic downturn has begun as well. New orders to distributors fell 10.3% in the first quarter of 1989 from year-ago levels. At a 12-month moving annual pace, orders in March rose only 7.4%, down from the speedy 31% rate of the previous summer.

No one disputes now that distributors' growth has slowed from 1988's bountiful path. The only question remaining: How far down do distributors have to go before sales head up again? The prognosis doesn't look too gloomy, especially compared with 1985, when NEDA orders tumbled 29%. This time around, Cahners Economics forecasts shipments will inch down only 2% and orders down 10% in 1989.

Good signals from the ELECTRONIC BUSINESS Leading Indicator, help from excellent inventory control and a "no recession assumption" are playing key roles in making the 1989 downturn so bearable.

Notes from the front line: In response to the March 20th column, Toby Mack of NEDA called to caution us with using Semiconductor Industry Association distributor sales figures. Don't forget, he warns, these are sales reported by manufacturers to distributors, so they should be read somewhat differently than the data NEDA reports. The semiconductor sales were much more volatile in 1984 and 1985 than NEDA shipments.

Cahners Economics and ELECTRONIC BUSINESS' sister publication, *Electronics Purchasing*, presented a paper at the Electronic Distribution Show in Las Vegas last month on how to use business cycles and the ELECTRONIC BUSINESS Leading Indicator to forecast distributor sales. For a free copy, please call me at (617) 558-4368 or write me at Cahners Economics, Cahners Publishing Co., 275 Washington Street, Newton, Mass., 02158-1630.

ELIZABETH BAATZ

A column on distributors will appear again on Sept. 18th.

C185U-2 A

SIX DOLLARS

A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

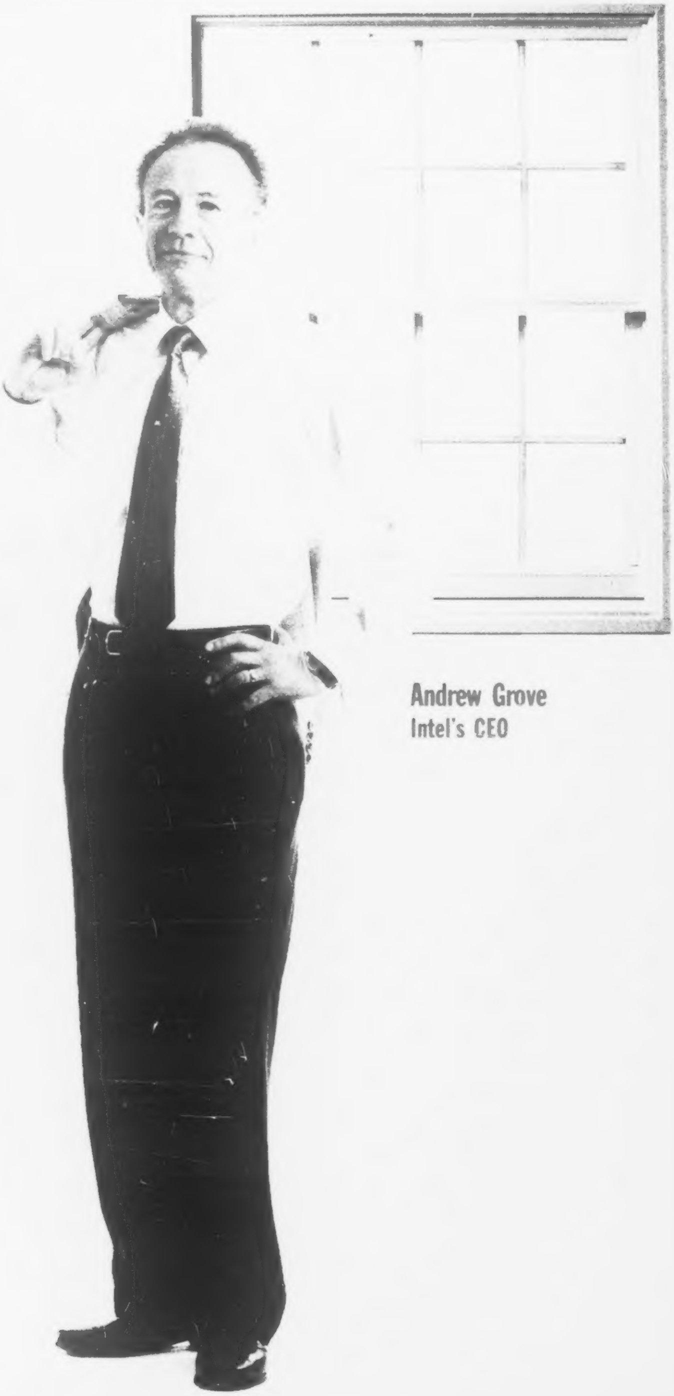
JULY 10, 1989

WINDOW OF OPPORTUNITY

The microprocessor marketing wars PAGE 28

Managing vendor relationships PAGE 42

Hedging foreign currency PAGE 54

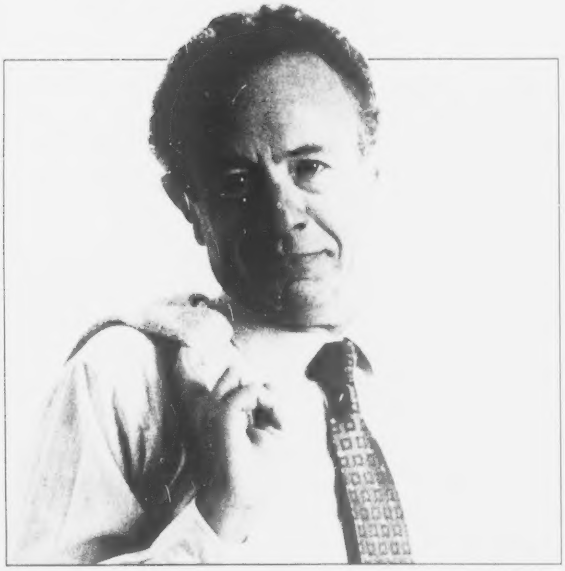


Andrew Grove
Intel's CEO

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 15, NO. 14 JULY 10, 1989



PAGE 28 Intel's Andrew Grove: "The 860 has a substantial possibility of confusing customers"

COVER STORY/STRATEGIES

28 The microprocessor marketing wars

An extraordinary "window of opportunity," guided by the clamor for RISC, has summoned U.S. microprocessor manufacturers to the marketing front — locking them in a struggle for the hearts and minds of key systems developers. At stake is a once-in-a-decade chance to establish a processor as a standard in the $100 billion office computing market. When the dust settles in this marketing war, the cost, forecast by one marketing guru, will top $50 million.

BUSINESS TRENDS

16 The quest for a better way to develop software

Around in one form or another for some 20 years, object oriented programming, promising productivity gains and cost savings, is suddenly catching fire among computer hardware and software vendors.

20 Permanent R&D tax credit means more investment

There is support in Washington to replace the temporary research and development tax credit with a permanent one. Electronics executives also are in favor, saying a permanent credit will offer greater continuity to R&D.

23 Digital scopes overtake long-favored analog

This year, for the first time, the digital storage oscilloscope market is expected to outperform analog oscilloscopes by 9%. And by 1992 that margin is forecast at 50%. Despite that growth, DSOs have yet to win full acceptance.

COVER STORY/STRATEGIES

28 The microprocessor marketing wars

In 1988, $15 million worth of RISC central processors were sold. Analysts are predicting that in the next five years the processors will consume up to 41% of the office market, making RISC anywhere from a $215 million to $1.3 billion market. There is no doubt that RISC is becoming the choice for a new generation. The marketing war to establish a RISC processor as a standard shapes up between giants Intel and Motorola, both once viewing RISC as faddish; and the more nimble Sun and Mips Computer Systems.

MANAGING RESOURCES

42 Making the most of your vendor relationships

It used to be that electronics manufacturers were satisfied with a common approach in choosing suppliers: give us the cheapest price and we'll give you our business. But that simple equation is changing. Manufacturers are willing to pay more to obtain higher quality components, timely deliveries, and improved service.

54 Hedging currency swings with new sophistication

The foreign exchange markets have turned less predictable than at any time in the past dozen years, but high tech's corporate treasurers have refused to be intimidated. They are using innovative techniques in the fickle foreign currency markets to protect profits — and even make some cash on the side.

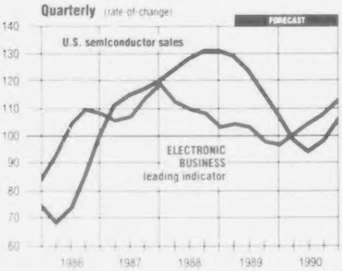
PAGE 11 CrossCheck Technology's Tushar Gheewala: Making it easier to test complex ASICs

PAGE 60 Ericsson's Bjorn Svedberg: "We will focus on the business we have now"

PAGE 63 Kubota's Naohisa Matsuda: Not looking to control the companies it invests in

PAGE 42 Maxtor's Steve Kitrosser: "It's easy to overlook how much the quality of a product buys you in cost"

PAGE 16 Object Management Group's Christopher Stone: "It's going to take a few years before the euphoria dies down"



PAGE 76 Business Barometer: Sales and profits indexes

EUROPE BUSINESS

60 It's telecom all the way for a rejuvenated Ericsson

Sweden's leading electronics firm once was a vocal supporter of the idea of converging computers and telecommunications. But now LM Ericsson has abandoned that doomed strategy to remain true to its roots telecom. It is making greater inroads into the United States and has realized strong profits after four disappointing years.

ASIA/PACIFIC BUSINESS

63 Japan's rust belt dollars feed U.S. high-tech firms

Facing no-growth futures, old-guard Japanese industrial companies are diversifying onto the U.S. electronics scene with their mountains of cash These sunset companies with their "patient" money tend to be interested in the long-term viability of the relationship, a marked difference from the typical U.S. venture capitalist.

MARKET PERSPECTIVES

68 Promises for MAP remain, but where are the buyers?

In the year since the Enterprising Networking Event show, nonproprietary Manufacturing Automation Protocol remains in a state that may be compared to suspended animation. Once-optimistic 1989 sales projections have been lowered by almost half, despite the unveiling of MAP 3.0 products. Price and software issues have led to a "wait and see" attitude.

BUSINESS BAROMETER

76 Sales and profits indexes

Profits to drop below year-ago levels in the last half of 1989, followed by slow and steady gains in 1990.

77 Leading indicator

Some upward motion may signal a more stable environment for semiconductors.

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Change at the top

Being section editor of ELECTRONIC BUSINESS, unlike what the title might indicate, allows me to do a little of this and a little of that. My job mostly has me scouring through mounds of manuscripts to ensure that the articles appearing in our magazine are clearly defined, tightly edited and, most of all, have value to our busy readers.

The little bit of this this time around has me announcing a change in the editorial leadership and direction of ELECTRONIC BUSINESS.

Jeff Bairstow, previously executive editor, is now sitting in the hot seat. That's my term for editor. Jeff has under his wing some impressive, experience-laden credentials in the three areas that concern us the most: journalism, business and technology. He has a bachelor's degree in electrical engineering and an MBA; he began his journalism career 20 years ago with *Electronic Design* and worked several years as a senior editor of *High Technology*. Before joining us in March as executive editor, Jeff was on the start-up team of *PC/Computing*.

Jeff Bairstow

Jeff takes over for John Kerr, who moves to editor-at-large with responsibility for reporting and writing special projects. The change at the top signals a refocus for us in our quest to continue to make ELECTRONIC BUSINESS the book of choice for management in electronics, computers and systems companies worldwide. As summer turns to fall, you'll read more comprehensive stories from Europe and Asia as we extend our coverage from London and Tokyo; you'll see beefed up financial and economic coverage and analysis as we add two additional editors to that department; and we're returning a full-time editor to Washington to track the goings-on of the world's most influential government. Stay tuned . . .

Welcome, Jeff, to the hot seat.

The microprocessor marketing wars

The 32-bit microprocessor business, says associate editor Michael Leibowitz, is the most prestigious, and perhaps most strategically important, semiconductor market in the world. It is an industry, Leibowitz notes, that is dominated by "crusty old engineers" who have had a disdain for marketing. But no more, as the clamor for RISC processing is opening a "window of opportunity" for chip companies such as Motorola and Intel. Our cover story illustrates how and why this costly battle is being waged on the marketing front.

MARVIN GREENE, section editor

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BPA ABP

Digital scopes overtake long-favored analog

DSOs are expected to outdo analog scopes by 9% this year and 50% by 1992. Still, pricing and acceptance are major issues

This year, for the first time, the digital storage oscilloscope market will outperform analog oscilloscopes by 9%, according to market estimates. Worldwide sales of DSOs are expected to grow to $620 million, 16% more than 1988 sales.

As recently as five years ago, the DSO market did not exist. If an engineer had a scope on his workbench it was analog. Increased sales of DSOs have caused a four-year erosion of the analog market. By 1992, says Galen Wampler, president of San Jose-based market research firm Prime Data Inc., the DSO market, having grown 18% since last year, will top the $1 billion mark and be twice the size of the analog market. "Combined, the scope market is still growing but analog is declining," Wampler says.

Despite the fast growth, the scope industry nonetheless faces a struggle to win market acceptance for DSOs while combating consistent downward pricing pressures. Vendors are trying to ease the transition by making digital scopes that look and feel like analog scopes and by offering scopes that have both analog and digital features.

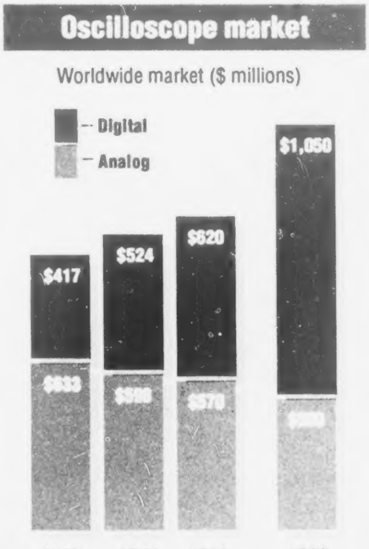
Because of the heavy R&D requirement, the DSO market is commanded by major players. The traditional heavy hitters — industry leader Tektronix Inc. of Beaverton, Ore., and second place Hewlett-Packard Co. of Palo Alto, Calif. — control 60% of the market between them. Netherlands-based N.V. Philips GL and Gould Inc. of Rolling Meadows, Ill., follow the two leaders with a combined share of about 20%, according to Wampler.

The battle for control of the DSO market started in 1984 when HP announced its first digital scope and discontinued its line of analog scopes. HP rapidly rose to a prominent position in the market at the expense of old rival Tektronix, which had previously dominated the analog market. Although today it is not among the top players, Nicolet Instrument Corp. invented digital scope technology.

Downward pricing pressures

Consistent downward pricing pressures and an uneducated customer confront both HP and Tektronix as they vie for dominance in the DSO market. Like creatures of habit, engineers are used to an analog scope. "People believe their analog scopes. They trust them," says Fred Rampey, Hewlett-Packard's R&D manager for digital scopes and logic analyzers in Colorado Springs. "Digital scopes have not reached that level of confidence but the barriers are falling."

All the major players have seen the need to inform the customer about the advantages of digital. As part of marketing efforts to enlighten the customer base, both Tektronix and John Fluke Manufacturing Company Inc. of Everett, Wash., have produced video tapes and sponsored seminars and focus groups to help customers understand DSOs.


Oscilloscope market
Worldwide market ($ millions)

Source: Prime Data Inc.

Analog-like digital scopes have eased the transition. "Scopes that have both analog and digital are helping customers," says Thomas Johnson, associate marketing manager of Philips test and measurement group at Fluke. Johnson says this is a transitional product that will last about five years. Vendors are also trying to speed market acceptance by making digital scopes that look like analog scopes where ever possible.

The other major challenge for vendors in the DSO market is the continuing downward pressure on prices. HP's first repetitive DSO had two channels at one gigahertz for a price of $18,000. Today's equivalent has four channels at 500 megahertz for $4,900. HP's Rampey says, "That's about a 4-to-1 improvement." A good rule of thumb is that the price/performance ratio will increase by a factor of two every two-to-three years, he says. This upward pressure on the price/performance ratio has all the industry players scrambling to keep pace with customer demands.

These intense pricing pressures are making manufacturing a key area of concern. Tektronix has concentrated on honing just-in-time techniques at its medium- to low-end scope division. Another way it meets these pressures is through a wide product offering. "We want to have a broad portfolio to address the price point the customer is going to pay," says Ronald Fowler, marketing manager of Tektronix's laboratory instruments division. The decreasing cost of the low to midrange scopes under $10,000 is also accelerating market penetration.

The lowered cost is causing the shipments to grow faster than sales for scopes below the $10,000 mark. The high-end DSOs, where performance is more of an issue, are less sensitive to these pressures. Unit volume and sales volume are "closer to parity" at the high end, says Fowler.

The digital storage oscilloscope market is poised to continue as the domain of the large players. They own the technological high ground and will continue to invest heavily in R&D to keep pace with market demands. "Now it is a marketing game to provide the particular price performance for the niche," says Prime Data's Wampler.

TONY GREENE

It's telecom all the way for a rejuvenated Ericsson

Sweden's leading electronics firm, its eye fixed on the U.S., is realizing strong profits after forsaking computers to stay true to its telecom roots

"Ericsson has the prerequisites to remain a strong and independent international telecommunications company," Bjorn Svedberg, CEO and president of Sweden's leading electronics group, declares unequivocally. Svedberg's enthusiastic assessment is certainly reflected in LM Ericsson's latest fiscal year financial figures that show the company returned to strong profits in 1988 after four years of disappointing results.

Ericsson raised its pre-tax profits for fiscal 1988, ended Dec. 31, to $299 million — a dramatic 66% increase over the previous year's figure of $180 million. This increase was achieved despite a 3.5% decline in 1988 sales of $5.4 billion. At first glance, the reduction looks disappointing, but in 1988 Ericsson sold two of the three units of its information systems division, which had accounted for more than 18% of its total sales the previous year.

The unloading of Ericsson Information Systems — a major drain on Ericsson's resources that prevented the group from living up to ambitions to become a computer systems leader — signals the company's seriousness about remaining true to its roots — telecommunications. As recently as a few years ago, Ericsson had been a vocal supporter of the idea of convergence of computers and telecommunications in building office systems. It eventually realized that such a strategy was damned, hence the reshaped focus on telecommunications.

"It is highly gratifying to note that concentrating our strength in our main business areas is yielding a stable increase in earnings and profitability," Svedberg says. "We will focus on the business we have now."

BY ELAINE WILLIAMS

First quarter 1989 figures released in May confirm the CEO's feeling. Worldwide order bookings increased 34% over the same period in 1988.

Analyst Hakan Filipson, who follows Scandinavian electronics companies for Baring Securities Ltd., London, says Ericsson's venture into computers was akin to "throwing good money after bad. It is very clear from the company now that they are focused." Restructuring and divestment, as in the case of selling the majority of the data systems division, and partnering lie at the heart of Ericsson's strategy.

Headquartered in Stockholm, Ericsson's core involves seven business areas that are dominated by three main sectors — public telecommunications, which represented 43.7% of business in 1988; radio communications, 15.2%; and business communications, 11.3% — all underpinned by strategic areas such as components.

Bjorn Svedberg, LM Ericsson president and CEO: "We will focus on the business we have now"

About 70% of the 113-year-old company's revenue, including almost 20% from Sweden, is derived from Europe, where its public telecommunications business is strong. In North America, the opposite is true. Ericsson is one of several secondary players, behind leaders United States-based AT&T and Northern Telecom Ltd. of Canada, in the mature telephone switching sector. However, Ericsson plays big in radio communications in North America, claiming a 24% share of the continent's high-growth celluar telephone systems market.

After reaching a peak of nearly 80,000 employees worldwide at the end of 1985, Ericsson's personnel numbers fell to about 65,000 at the end of last year. "Restructuring measures will be the rule and not the exception," asserts Svedberg.

Cost cutting also includes moving its telephone manufacturing activities away from Sweden to the Far East over the next two years. Says Svedberg: "It is not possible to achieve profitable production of telephone instruments in Sweden." At the end of last year about half of the firm's workers were based in Sweden, where labor typically is costly, and some companies there, including Ericsson, have been hit by strikes.

In its public telecom business, Ericsson vice president John Meurling says that next year the company will buy computer hardware to provide the maintenance and support it needs for its management systems that are linked to its AXE telephone exchanges. AXE, the company's digital electronic exchange technology, forms the basis for Ericsson's telecommunications products. Previously, the company had its own proprietary hardware to do the job, but it is no longer a core activity.

Ericsson is still divesting other parts of the company that do not fit into its overall telecommunications strategy. Recently, it sold off its signaling division that provides electronic equipment for rail and road signaling equipment.

Part of its components division, with 2.3% of total sales in 1988, also has been sold off, as Ericsson intends only to manufacture those components that are of strategic importance and that add value to its products. So this spring, Ericsson let go its RIFA capacitor business along with the name; capacitors represented some 20% of the components division sales. With no strategic importance, Ericsson saw that capacitors would take a considerable investment to keep up with the most recent technological advances.

Instead, the components business will concentrate on its ASIC technology, thick- and thin-film hybrid expertise and power supplies, where it can see a growing market. Ericsson Components sells 70% of its output to the Ericsson group, although this part of the group has a three-tiered strategy that includes selling to other telecommunications companies and to the industrial market. The components division feels that volume manufacturing is vital for its profitability, and, because some 16% of sales goes back into R&D, it must make efficient use of its developments. It has an R&D operation in the heart of Silicon Valley in order to be close to ASIC developments.

Seeking partners

Partnerships, like restructuring, are key to Ericsson's strategy. But the company insists it won't partner its core products, such as the AXE switch system. "We are looking for partners to share development," says Meurling.

Ericsson raised its 1988 pre-tax profits 66% over the previous year

Ericsson currently is seeking suitable allies to develop lower cost optical lasers, Meurling adds, and in another field has signed an agreement with Texas Instruments Inc. TI will offer the manufacturing technology for ASICs and Ericsson will design the circuits for the chipsets. Analyst Filipson says the TI-Ericsson deal could be advantageous for both companies because "they are not in a competitive position with each other."

Svedberg says a further example of Ericsson's technology-based partnering is an agreement between Ericsson and Matra SA in France for joint development of products for the Pan-European cellular phone system, which is to cover 18 countries by 1991. The object of any agreement should be either to share costs or to get a better access to markets, he explains.

However, Svedberg does rule out any possibility of merging with another company despite the industry's trend toward mergers, such as the Italtel SpA and AT&T agreement and the ongoing rumpus between Siemens AG, Britain's General Electric Co. and The Plessey Company Plc. Asserts Svedberg: "We are one of the top players from a volume point of view. We don't need a big bang merger."

Svedberg points to the increased opportunities in many telecommunications markets, with many traditional public telecom firms now facing open competition with new private companies for the first time. This deregulation and divestiture began in the United States and is being repeated throughout the world.

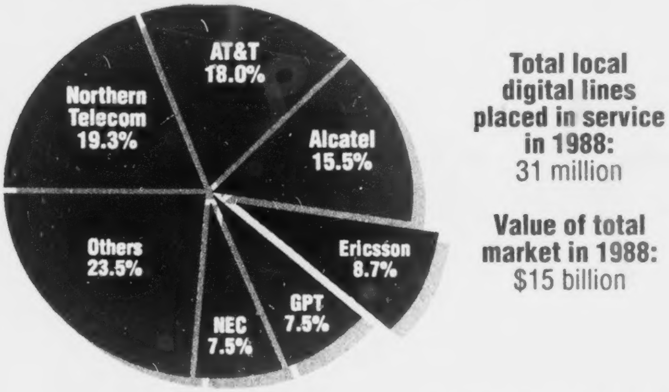
The installed base worldwide of some half-billion local telephone lines, including an estimated 127 million in the United States, will eventually be replaced by digital technology. In 1988 the digital switch replacement market totaled 31 million lines, according to market researcher Northern Business Information Inc., and Ericsson claimed an 8.7% share of that, although located well outside the United States.

Ericsson's objective in the U.S. is to become the third player in the market behind AT&T and Northern Telecom. "That is our goal," says M. Peter Thomas, president and CEO of Ericsson Inc., the company's Richardson, Texas-based U.S. subsidiary. But Ericsson's move into the U.S. switch market — dominated by AT&T's and Northern Telecom's combined 90% share — has been slower than anticipated, and "there has not been the replacement that everybody expected," says Steve Kropper, senior consultant for International Data Corp., Framingham, Mass.

Third-player competition also is coming from West Germany's Siemens AG and Japan's NEC Corp.,

Worldwide public telecommunications market

Share of total local digital lines placed in service in 1988



Source: Northern Business Information Inc.

among others. "[Ericsson is] finding it tougher in the United States than expected," according to Suzanne Brennan, product manager, world telecom markets, Northern Business Information Inc., New York City. "The question is, will the regional holding companies give these third suppliers sufficient business to be in the market?" Thomas concedes that the "market isn't growing very fast." The regional holding companies "aren't desperate to add anybody," he says.

Brennan points to 1993 — the target year for replacing much of the current analog switching equipment — as a break point for Ericsson if it is to realize ambitions to be the third player in the U.S. market. "They must show they have the technology and applications." Thomas, while deemphasizing 1993 as a make-or-break year, acknowledges, "The change out of those switches is an important event."

For its part, Ericsson believes its AXE switching technology gives it an advantage. Svedberg calls the AXE a "flexible product for tomorrow. Many parts of the specification have not been written so that we can incorporate new features." Thomas, likening the switch's technology to a real-time computer system, notes that the AXE's architecture is defined by its software and not its hardware.

Business communications, like public telecom, is a cutthroat business. "No one is making any money in it," says Ronny Lejdemalm, president of Ericsson Business Communications, but Ericsson is determined to be a world player. The business communications division of Ericsson Inc. recently won a $29.5 million contract to supply what is going to be the largest private PBX system in the world to the University of Massachusetts. Ericsson is supplying its high-capacity MD110 technology — based on AXE principles — to connect 400 buildings and more than 30,000 lines in a single system. The company sees the order as a breakthrough in the U.S. market.

M. Peter Thomas, president and CEO of Ericsson's U.S. subsidiary: Our goal is to become the third player in the U.S. telephone switch market

Ericsson applies its heralded AXE technology beyond the public telecom and business communications sectors and into its third major activity, radio communications. AXE, for example, forms the core switching element in its cellular phone equipment. In the cellular systems market, in addition to its 24% stake in North America, Ericsson claims a 40% world share.

Mobile telephones certainly breathed new life into what is a very mature and staid sector of the telecommunications industry. Last year, the number of cellular subscribers increased by about 44% worldwide, and a similar growth is expected for this year. It is sometimes easy to forget that the first cellular mobile telephone service was only launched in 1981. Now there are more than 4 million subscribers worldwide, and networks are in service or planned in nearly 50 countries around the world.

Restructuring and partnering lie at the heart of Ericsson's strategy

Ericsson's positioning in cellular balances its risk in the United States, according to analyst Brennan of Northern Business Information. "Certainly their strength in cellular can't hurt them in the United States. It can only help them."

Meanwhile, as Europe has now agreed on new standards for mobile telephone systems, Ericsson, with its pioneering work in the Scandinavian market, is well placed to supply systems to the European market. In France, Ericsson is working closely with Matra, and it has worked with Siemens in the West German market. And Orbitel Ltd., which is co-owned by Racal Electronics in Britain, operates one of the British cellular networks and has agreed to buy the Ericsson equipment.

Ericsson believes that the next major development will be the creation of public mobile networks that are designed for data rather than voice communications, and to this end the company has been promoting the Mobitex system standard. In May, Ericsson signed a $55 million agreement with a subsidiary of RAM Broadcasting Corp. for equipment that will be used in the intial phase of the first Mobitex system in the United States.

Mobitex is already in service in Sweden and is being installed in Canada, and because of the strong interest from other countries Mobitex is being offered as an "open" standard for public mobile data networks. Full technical data on the open air radio interface is being published by Ericsson so that any other manufacturer can supply terminals equipment while the Swedish company retains the central switch technology. This then plays to Ericsson's strengths. As vice president Meurling puts it, "Ericsson is good at switching, but it has not been as good at handling peripherals."

"After the divestiture we went through a major corporate hiccup. But Ericsson has now gone back to its main business — telecoms," says Meurling. "[Office automation] has not been a great success for anyone in telecommunications." Meurling cites the renegotiated AT&T deal with Ing. C. Olivetti & Co. and the difficulty between Rolm and IBM.

Ericsson's global focus is in keeping with a company that has always been forced to export. Only a small percentage of its total business comes from Sweden, even though the company represents around 70% of the total electronics output in its homeland. "Competition is our world," says Meurling. "We've never really had the protection of a large home market. The question is: Can we afford to keep up the pressure?" ☐

[Conversion rate: 6.145 krona = $1]

Promises for MAP remain, but where are the buyers?

Optimistic 1989 sales projections have been lowered, despite the unveiling of MAP 3.0 products. Price and software issues lead to a "wait and see" attitude

BY SYLVIA TIERSTEN

Build a better mousetrap — and they'll beat a path to your door, the cliche goes. Well, maybe — but not if that mousetrap is technology that is new, unproven and costly, and not if the installed base of conventional traps is extensive. Manufacturing Automation Protocol presents such a case.

MAP, a nonproprietary computer networking protocol for factory floor automation, is intended to establish a standard means of communication between computers and production cell equipment in a multivendor environment. A standardized network, MAP proponents argue, can reduce costs associated with training, installation, maintenance, spare parts inventory, updating, wiring, custom hardware and software.

General Motors Corp. created MAP in the early 1980s. GM offered a feasibility demonstration at the 1984 National Computer Conference and followed up a year later with 2.1 and 2.2 MAP specifications to enlist vendor support. It anticipated a flood of MAP products by 1986 that never came.

Fearing that 2.X standards were emerging standards with a short shelf life, many potential vendors and users decided to wait it out. And many of them are still dragging their feet more than a year later — despite the unveiling of MAP 3.0 prototypes at last year's Enterprise Networking Event in Baltimore and the freezing of 3.0 standards for upward capability through 1994. Proprietary Ethernet still outsells nonproprietary MAP by about 5 to 1.

In the short term, the bears remain bearish on MAP, and even some of the bulls have revised their projections downward. Market research firm Dataquest Inc., which originally predicted $115 million worth of MAP sales to the North American market in 1989, is now anticipating $59 million.

"The ENE show didn't have the galvanizing effect everyone thought it would," says Robert George, a senior industry analyst at Dataquest. "People seem to be standing back and saying, 'I'll let other companies make the mistakes, while I wait till there's more support available — and more applications software.' "

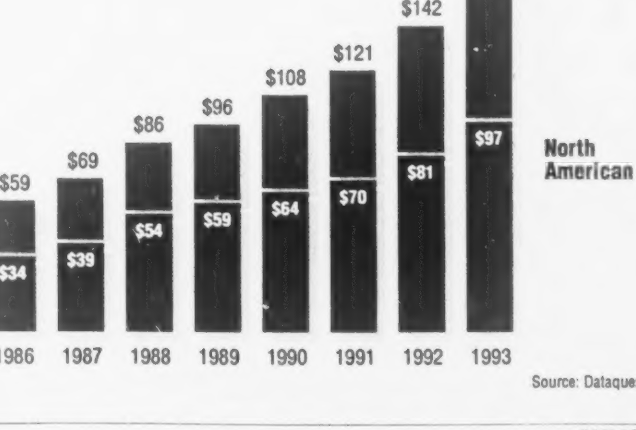
Dataquest now is estimating a 12% increase in 1989 sales of MAP and Open Systems Interconnection (OSI) products to North America over last year's $54 million, and a 13% compound annual growth rate from 1990 to 1993. OSI, of which MAP is a subset, is a series of communications standards developed by the International Standards Organization for the interconnection of communication-oriented computer equipment with varying protocols.

Price, utility issues

Price and utility remain critical issues in assessing MAP's ultimate success in the marketplace. While process control and automotive manufacturers value MAP's ability to run on 802.4, noncollision token bus media, other users may be more inclined to settle for proven, less-costly proprietary solutions. As for Ethernet, any rumors of its impending death have been greatly exaggerated. "Ethernet is very well entrenched and remains a good solution for large file transfer on an irregular basis," notes George. North American sales of the product last year reached $259 million, according to Dataquest, which is pro-

MAP sales: Growing but not taking off

Sales include hardware and software ($ millions)



Source: Dataquest Inc.

jecting average annual growth of 15% through 1993.

Over the next 10 years, the fortunes — and price profile — of MAP will be tied into computer integrated manufacturing implementation, says George. He anticipates a 25% annual price cut in MAP products over the next five years. Assuming that a reasonable volume develops for MAP products, prices for Ethernet and MAP should be roughly comparable by 1993.

The new MAP 3.0 products, unlike their 2.X predecessors, offer some degree of functionality at all seven protocol layers. These are, in ascending order: physical; data link; network; transport; session; presentation; and application. The presentation layer, which earlier MAP products did not have, provides translations between standardized data formats. MAP 2.X also lacked network management capability and directory services in the application layer.

Few exhibitors were actually ready to deliver alpha and beta-tested MAP 3.0 by the conclusion of the ENE show. But by the end of this year, "every vendor of any importance will have a 3.0 connection — and that's what the show accomplished," says Tony Helies, president of Concord Communications Inc., a Marlboro, Mass., maker of MAP/TOP (Technical and Office Protocol) products. Even Digital Equipment Corp., a staunch defender of Ethernet, has MAP 3.0 products in the offing. Concord shipped its first 3.0 products last August. Helies claims MAP sales for the first quarter of 1989 are 70% higher than last year.

The lull since the ENE show actually has been "a quiet period of vendor engineering and testing," notes Paul Accampo, business development manager for Hewlett-Packard Co.'s information networks group. Those who expected a blizzard of MAP implementations in 1989 may have underestimated sales cycle time for a shop floor control project. HP, he says, is currently talking with "over 20 customers" about specific 3.0 MAP network installations.

Although 1988 was not "the year of MAP in terms of product," it was "the year of MAP in terms of technical specification milestones," says Michael Kaminski, manager of communications/MAP of the advanced engineering staff of GM. The star of the ENE show was an OSI network for the custom manufacture of products in a multivendor, computer-integrated environment. The Society of Manufacturing Engineers, which operated the 1988 show, is planning a reprise for 1991.

Potential of GOSIP

Another development that could augur well for MAP in the long run is the adoption of the GOSIP (Government Open Systems Interconnection Profile) program by the U.S. government. Since GOSIP will become mandatory for federal government agencies on Aug. 15, 1990, virtually every major procurement RFP will require bidders to offer an OSI stack. A stack is a set of OSI protocols with defined options starting at Layer 1 and going through Layer N, with N no greater than seven.

Over the next 10 years, the fortunes — and price profile — of MAP will be tied into CIM implementation

"OSI will make it — no matter what. The question is when," muses Robert Franklin, product marketing manager, communications, for Motorola Inc.'s microcomputer division. The answer, he thinks, is more than a little price dependent, particularly when it comes to MAP 3.0 and factory floor implementation. "We came away from the ENE show with a really good feeling — but it didn't result in a lot of sales," says Franklin. "It's still hard to justify a $4,000-per-node as opposed to a $1,000-per-node cost to someone who wants to build a factory with 5,000 connections."

Most MAP systems are currently priced at over $2,000 for modem, software and two controller boards. Franklin supposes that a single-board system with built-in modem and software that sold for under $1,000 would make MAP more competitive against Ethernet. But prices will not sink to this level until a major user — read GM — buys huge quantities of MAP 3.0. Ethernet currently bears a $1,000 to $2,000 cost-per-node, compared to $3,000 to $4,000 for MAP.

Production of a $1,000, single-board, single-slot system would require miniaturization of a broadband modem. If this technical feat is market-driven, "you're looking at one year," Franklin estimates. If the user demand is not there, "you're probably looking at four or five years" to produce a one and one-half inch square modem at a cost of under $100, he says.

GM's Kaminski sees the price issue in a different light. In choosing between 802.4 media and Ethernet, "you're being penny wise and pound foolish if all you look at is connection cost," he says. "You have to look for the most cost-effective solution — and that's not necessarily the cheapest product."

Within the next 12 to 18 months, Kaminski says, GM will probably install eight or nine plants with MAP 3.0 networks. But product mixes change, timing environments change, and betting the farm on GM automation plans has cost robotics and automation vendors dearly in the past.

Fluctuating standards and a narrow marketplace, meanwhile, deterred robot makers from investing heavily in high-performance 2.X MAP interfaces. These companies "needed to feel that their investment would be recoverable within three to five years of sales," explains Henrik Schutz, industrial computer product manager at GE Fanuc Automation North America Inc., Charlottesville, Va. Now that 3.0 specifications are firmly in place, Fanuc Ltd. of Japan, which has a 50% ownership stake in GE Fanuc, is building robots with MAP interfaces.

GE Fanuc, which provided 2.X MAP interfaces for its programmable controllers and computer numerically controlled (CNC) machine tools, is currently developing 3.0 product. So is Allen-Bradley Co., which also caters heavily to the factory automation market. But major computer vendors, with less of a stake in the manufacturing world, "do not view MAP as an important opportunity to the extent that we do," according to Schutz. If IBM and DEC are relatively unenthusiastic about MAP, that's understandable, he concedes, but it is also "a problem, since the purpose of MAP is to tie computers to automation controllers."

Boeing, a longtime champion of MAP/TOP, recently circulated two RFPs for new production facilities. In one instance, the end user opted for an OSI solution and is developing MAP 3.0 prototypes and applications. In the second case, the user chose a proprietary network with a commitment to an OSI migration path, because the time frame was short and "the end user was not comfortable that he was at a solid product level for OSI," according to Laurie Bride, manager of network architecture for Boeing Computer Services in Seattle.

Manufacturing Messaging System (MMS) protocol, an applications protocol for machine-to-machine communications that works well with robots, and 802.4 interfaces were unavailable in a 3.0 format. "Faced with a short leadtime to bring a facility on line, you don't really want the first release of the product, but something that's a little more stable," says McBride, "and many users are running into that situation."

Furthermore, not every end user wants to be a pioneer or early adopter of technology. "If our major suppliers of distributed control systems, programmable controllers and computer equipment had MAP products, we would probably be using them right now," says Everette Eldridge Sr., an electrical engineer in control systems engineering at Tennessee Eastman Co., a chemical manufacturing arm of Eastman Kodak Co. However, Eldridge's enthusiasm for MAP implementation is tempered by "the development work that needs to be done as far as application interfaces. We wouldn't just jump in and buy product if there's no software to run through that product."

MAP 3.0 product is still unavailable for network management and directory services. And there is a dearth of MMS product at the machine control level, notes Bruce Gengler, network consultant at Deere Technical Services in Moline, Ill. Deere is beta testing MAP 3.0 in a pilot project that involves downloading CNC information to laser-based cutting machines.

Applications software is an endemic problem in manufacturing — and MAP implementation could go a long way toward solving it, reasons Andrew McMillan, executive vice president of Industrial Technology Institute, a not-for-profit R&D corporation in Ann Arbor, Mich. "There are not a whole lot of Lotuses out there for manufacturing right now, because you don't have a common environment," he says.

The World Federation of MAP/TOP User Groups is developing an international conformance testing program for MAP and TOP profiles, and ITI is the contractor for organizing this effort. The goals are to harmonize tester and user industries worldwide and develop accreditation for test centers. Federation procedures should be in place by July, says McMillan, who heads its North American delegation. ☐

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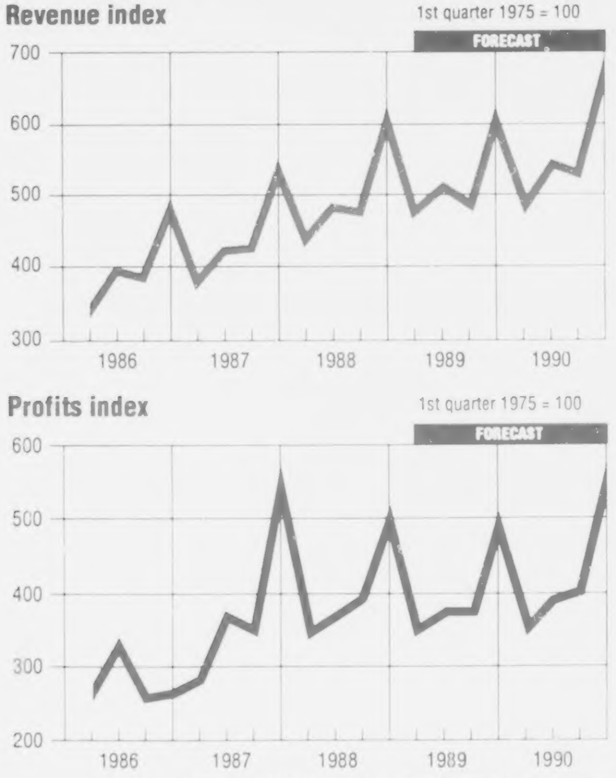
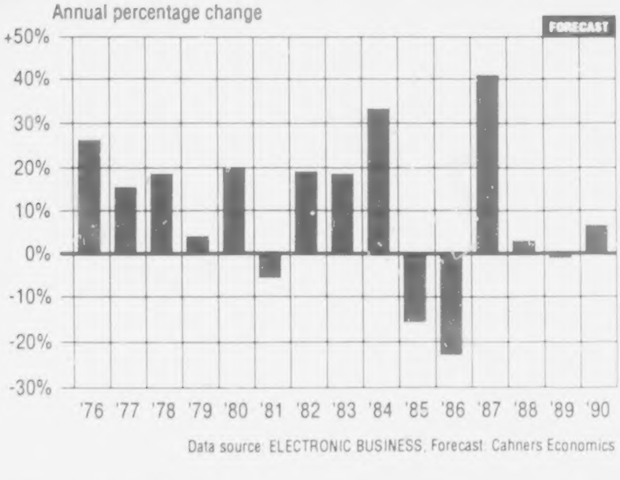


Data source: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Electronics long-term profit performance



Data source: ELECTRONIC BUSINESS, Forecast: Cahners Economics

Lackluster profits set stage for cost cuts

Profits at electronics companies continued to grow in the first quarter of 1989, although growth was limited to 0.4% above year-ago levels. After a 10% year-ago decline in profits during the final quarter of 1988, the stable profit picture in early 1989 is reassuring news. The outlook for profits later this year: Expect profits to drop below year-ago levels in the last half of 1989, followed by slow and steady gains in 1990.

Profit gains over year-ago levels were shared across the board among ten of the sixteen companies ELECTRONIC BUSINESS includes in the industry index. In the semiconductor industry, Advanced Micro Device's profits weakened, while Intel Corp. and Motorola Inc. profits experienced gains. Likewise, in the computer industry, Digital Equipment Corp.'s profits slipped while IBM's profits rose.

After mixed profit performance in early 1989, all companies will be struggling to maintain profit growth later this year. One reason will be much slower revenue gains. Revenue growth, which peaked at a year-ago rate of 14.9% in early 1988, had inched down to a 9.2% growth rate by early 1989. Favorable operating conditions last year are giving way to less favorable conditions now. End-market growth is slowing, business investment growth has passed its peak, and inflation is picking up steam.

Limited cutting options

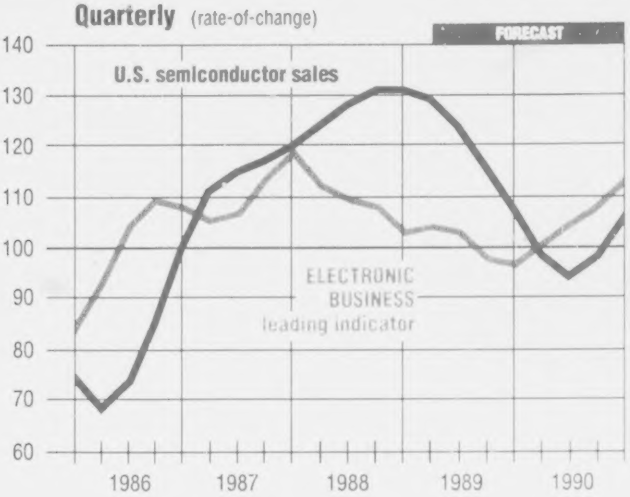
How many cost-cutting options do electronics companies have? Inventories, which have traditionally been an unpredictable and often high cost, have been kept low. Labor, which has never been a large share of costs, will not have much impact in the cost-cutting equation. Cutting R&D, which already suffered significant declines during the last recession, may be an option once more. Whatever the final decisions, the options are limited. So despite Wall Street's pressure to increase short-term profits, 1989 will most likely be a lackluster year for the bottom line.

Keep 1989 in perspective: Electronic company profits tumbled 17% in 1985 and 23% in 1986. The next two years are more likely to see profits dip 1.3% in 1989 and rise 7% in 1990, thanks to the recession-free slowdown in electronics industry revenue.

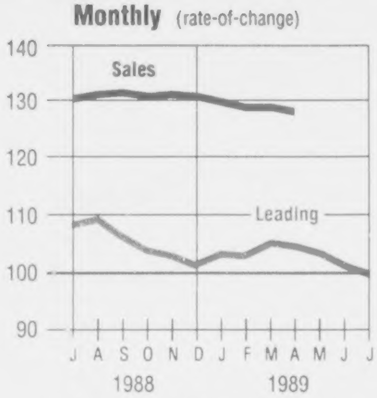
ELIZABETH B. BAATZ

ELECTRONIC BUSINESS *profit and revenue index will appear again in the October 2 issue*

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368.



The ELECTRONIC BUSINESS leading indicator jumped to 105.0 in March, up from 102.8 in February. These early months of 1989 have shown some jerky upward motion, signaling a more stable environment for semiconductors and electronics in 1989 and 1990 than previously thought.

Source: Cahners Economics

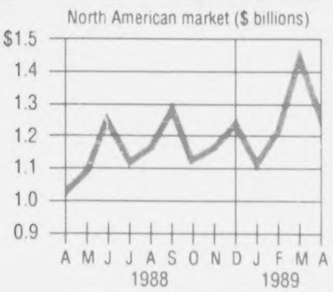
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, March)	105.0	102.8	110.9	107.6
U.S. semiconductor bookings ($ millions, 3-month average, April)	$1,358	$1,345	$1,223	$1,178
Weekly hours of semiconductor production workers (monthly average, March)	39.5	39.3	40.2	40.2
Electronic components leadtime index (1977 = 100, May)	110.6	117.7	114.9	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, April)	51.3	47.4	60.1	54.4
Change in electronic components inventories ($ millions, SA, March)	+$43	+$95	+$29	+$80
Contracts and orders for plant and equipment ($ billions, SA, March)	$42.6	$41.3	$36.4	$39.4

SA = seasonally adjusted, all other data is not seasonally adjusted

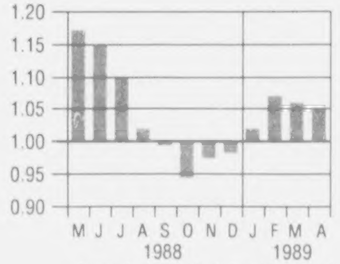
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



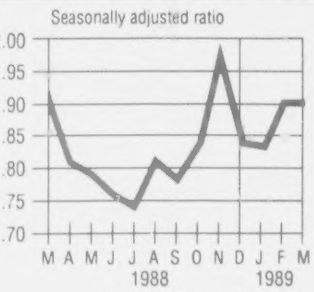
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department

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Electronic Business®

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

JULY 24, 1989

THE TOP 200 U.S. ELECTRONICS COMPANIES

PAGE 24

Will Amphenol wake up? PAGE 66

Venture capitalists play it safe PAGE 76

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES — WORLDWIDE

VOL. 15, NO. 15 JULY 24, 1989

PAGE 26 Vibrant foreign sales can't mask discouraging indicators

COVER STORY/THE ELECTRONIC BUSINESS 200

24 Top line rises 9.5%, but the bottom line falls 3.2%

Results of the exclusive ELECTRONIC BUSINESS 200 show that 1988 generally was an upbeat year on the sales front for U.S. electronics and computer companies — but nonetheless it was a year rife with disturbing financial indicators. Total sales grew to $327.7 billion in 1988 from $299.2 billion in 1987. But the improvement in sales may be deceiving because the increase comes almost exclusively from foreign markets. In fact, foreign sales of the 200 rose 42.1%, while U.S. sales were up only 2.4% — suggesting that the domestic economy is slowing down for these companies.

BUSINESS TRENDS

17 After AT&T, Olivetti eyes U.S. vertical markets

Olivetti has formulated a new strategy for penetrating U.S. markets that coincides with a recent company-wide restructuring. In an interview, managing director Vittorio Cassoni says the Italian computer maker will focus on three U.S. vertical markets — banking, retail and government.

THE ELECTRONIC BUSINESS 200

24 Top line rises 9.5%, but the bottom line falls 3.2%

The ELECTRONIC BUSINESS 200, gleaned from countless annual reports, 10-K filings, exclusive interviews and internal estimates, offers a detailed view of last year's performance by electronics companies at the top of the heap. It also provides insight into the direction of the U.S. electronics industry. What the figures show is not encouraging.

26 Vibrant foreign sales can't mask discouraging indicators

The U.S. electronics industry isn't exactly sick. But according to the 1988 ELECTRONIC BUSINESS 200, its vital signs indicate a financial weakness that foretells problems. While total sales grew by 9.5%, net income fell 3.3%.

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76 Electronics financiers prefer to play it safe

Venture capital has been bitten by the LBO bug, and that is bad news for electronics entrepreneurs who are seeking early- or middle-stage financing. Stung by declining investment returns on their earlier stage deals, some venture capitalists have turned to backing established high-tech companies as a way to reduce risk and speed paybacks.

82 Who's who in venture capital for the electronics industry

Results of the ELECTRONIC BUSINESS annual survey of venture capitalists that serve the electronics industry.

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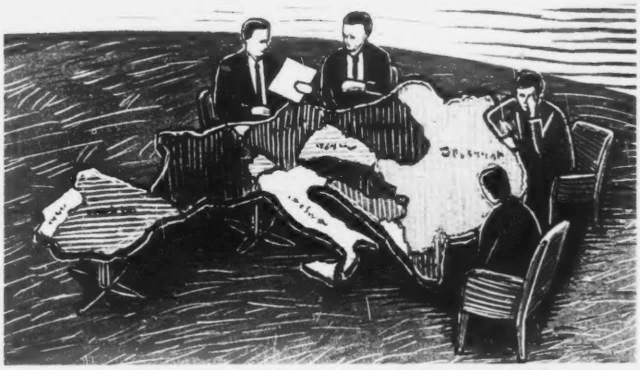
Skolos/Wendell/Raynor



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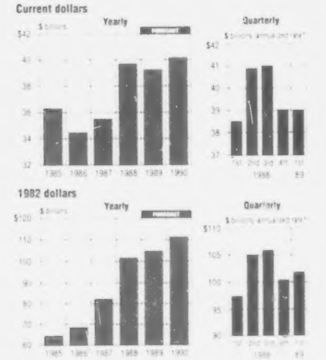

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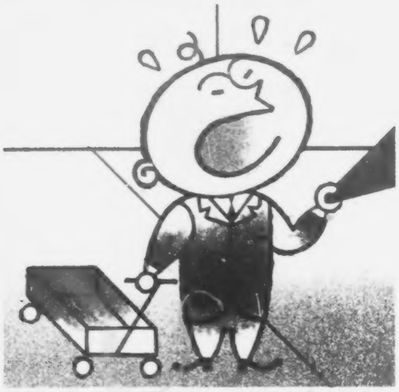
PAGE 17 Olivetti's Vittorio Cassoni: "The relationship with AT&T was never meant to penetrate vertical markets"



PAGE 76 Trend in venture capital: Cut risk and invest in mature firms

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95 European standards panel: Americans, keep away!

Walls — in the name of standards — are going up around Fortress Europe. An EC committee is determining the technical product standards that will apply throughout Europe after its unification in 1992 — all without the input of Americans. The fear among U.S. manufacturers is that they will lose access to Europe.

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105 Multinational workforces on the rise in Japanese firms

Ready or not, Japan's big electronics exporters have become multinational companies. Scrambling to counter the high yen, major Japanese electronics companies have moved some 15% to 30% of their total production offshore in the past several years. With a workforce 30% to 50% non-Japanese, the task now is to make it work.

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Vendors of Video Graphics Array products for the IBM personal computer and compatible marketplace are facing some critical decisions. Already confronted with increased competition and falling prices, vendors must start thinking about the future where IBM and TI are primary competitors for the next generation of products.

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The market for scientific and engineering instruments has reached its peak and growth rates are slowing down. Shipments will grow by 4% to an annual total of $50.8 billion by the end of 1989, and inch up another 3% in 1990.

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A pullback in U.S. business purchases of computers and office equipment suggests buyer uncertainty about the economy and standards, and that many businesses already upgraded their systems and won't be buying as much this year.

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116 **An index of the companies covered in this issue.**

INSIDE BUSINESS

The 200

Every organization has its benchmarks by which it measures continued success and effort. Apple has its Mac, and Motorola its 68000 microprocessor. And it's a big deal in the sports world when a Roger Clemens wins 20 games.

We, too, at ELECTRONIC BUSINESS have a standard, and that's the ELECTRONIC BUSINESS 200, our exclusive annual ranking of the top 200 publicly held electronics, computer and systems companies in the country. The ELECTRONIC BUSINESS 200 is a compilation of everything that we do here and, we hope, everything that we do well. The listings we give throughout the year — such as the fastest-growing or most profitable companies — are all signs that lead to the 200.

The process of producing the 200 is a yearlong one for senior editor Linda Stallmann, who laboriously tracks, collects, sorts, analyzes and charts hundreds of annual reports, 10-K filings and company press releases. Linda's research comes to a head around May, when various trends begin to emerge. For example, this year's 200 listing shows a rising top line, but a falling bottom line. And falling profits in 1988, Linda says, portend some discouraging financial problems on the horizon.

Bruce Rayner

Linda Stallmann

Our listing is buttressed by many pieces of information. Linda and fellow senior editor Bruce Rayner have penned an introduction that sums up some of the major trends, such as the 42% increase in foreign sales. Further analysis comes by way of "Facts behind the Figures," "Rankings by Industry Segment," and "Best and Worst Performers."

As in previous years, the 200 is also available on disk (both IBM compatible Lotus 1-2-3 and Apple Macintosh Excel versions). The cost is $100. For three years of the 200 (covering 1986, 1987 and 1988), the cost is $200. To order, please write assistant editor Xiong Xiaoge, ELECTRONIC BUSINESS, Cahners Building, 275 Washington St., Newton MA 02158, or call him at (617) 558-4230.

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THE ELECTRONIC BUSINESS 200

The top line rises 9.5%, but the bottom line falls 3.3%

The ELECTRONIC BUSINESS 200, compiled over several months by senior editor Linda Stallmann, is an exclusive report that analyzes the financial statements of the 200 largest, publicly held electronics, computer and systems manufacturers based in the United States. The intent of our research is to provide an accurate gauge of the current status—and future direction—of the industry. In capsule, 1988 was an upbeat year on the sales front for the U.S. electronics industry, but nonetheless a year rife with disturbing financial indicators.

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Foreign sales flourish, domestic sales flounder

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THE ELECTRONIC BUSINESS 200

Vibrant foreign sales can't mask discouraging indicators

While foreign sales for the 200 flourish, U.S. sales and total profits flounder. Two other key indicators — return on investment and return on equity — are both down

BY LINDA STALLMANN AND BRUCE C.P. RAYNER

The U.S. electronics industry isn't exactly sick. But according to the 1988 ELECTRONIC BUSINESS 200, an exclusive annual listing of the top 200 public electronics companies in the country, its vital signs indicate a financial weakness that foretells chronic problems.

The ELECTRONIC BUSINESS 200, gleaned from countless annual reports, 10-K filings, exclusive interviews and internal estimates, gives a glimpse into last year's performance by electronics companies at the top of the heap. It also provides insight into the direction of the U.S. electronics industry.

What the figures show is not encouraging.

Sure, total sales grew 9.5% to $327.7 billion in 1988, up from $299.2 billion in 1987. That rates as the best growth since the boom year of 1984, when annual growth measured a healthy 13.4%. But the improvement in sales is deceiving, since they come almost exclusively from foreign markets. In fact, foreign sales of the ELECTRONIC BUSINESS 200 rose 42.1%, while U.S. sales were up only 2.4% — suggesting that the domestic economy is slowing down for these companies.

The reason? A maturing U.S. market and stiff foreign competition from Japan and Europe. The top U.S. electronics companies, most of them transnationals, are focusing more and more on growing foreign markets across both the Pacific and Atlantic oceans. In particular, they are scrambling to get into Europe by the end of 1992, when intra-European trade barriers will come down.

IBM: 4.4% profits increase

Indicative of this trend is IBM, the top performer on the ELECTRONIC BUSINESS 200 since it was first published in 1978. In 1988, IBM posted total sales growth of 8%, with overseas sales of $34.4 billion and growing at a rate of 15.5%. Big Blue's U.S. sales, however, slipped marginally to $25.3 billion from $25.5 billion in 1987. IBM's 1988 profits accentuate the trend set by sales: up by 22.3% in foreign markets, down by 27.3% in the United States, for a total net profit increase of 4.4% (before the effect of an accounting change).

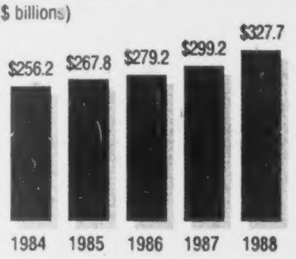
IBM's overall profit growth is an exception to the rule. Net income for the top 200 U.S. electronics companies fell by 3.3%, after logging a stellar 53.7% growth in 1987. This year's poor performance makes it three out of the last five years that the ELECTRONIC BUSINESS 200 listing has posted negative profit growth. True, it is hard to follow up a year like 1987, but the wild swings since 1984

Composite performance of the ELECTRONIC BUSINESS 200

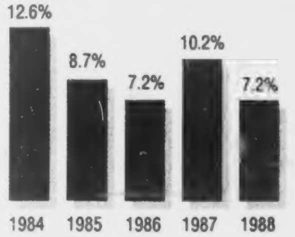
	1984	1985	1986	1987	1988
Electronics sales ($ billions)	$256.2	$267.8	$279.2	$299.2	$327.7
Total sales ($ billions)	$776.5	$797.8	$641.7	$689.7	$774.5
Total net income ($ billions)	$46.4	$35.4	$26.7	$41.0	$39.7

WEIGHTED AVERAGES	1984	1985	1986	1987	1988
Return on equity	16.5%	11.8%	10.2%	14.1%	13.1%
Return on investment	12.6%	8.7%	7.2%	10.2%	7.2%
Cost of goods sold/sales	69.4%	70.3%	63.7%	61.5%	58.6%
R&D/sales	4.2%	4.2%	5.0%	5.2%	5.1%
Sales per employee	$103,200	$110,800	$102,348	$113,533	$128,756
Net income per employee	$6,300	$5,000	$4,266	$6,662	$6,646
5-year compound annual growth					
Sales	+8.5%	+5.0%	+8.2%	+10.7%	+11.5%
Net income	+11.6%	+1.4%	+4.0%	+13.9%	+8.3%
Capital outlay to net cash flow after dividends	96.0%	118.3%	97.9%	73.9%	83.8%
Debt/total capital	23.5%	26.7%	29.9%	28.2%	45.3%
Foreign sales/total sales	—	14.0%	25.4%	24.9%	31.5%

Electronics sales



Return on investment



have serious implications for the industry's long-term health.

In total, 28 of the ELECTRONIC BUSINESS 200 are red-ink companies in 1988, up from 23 in 1987. No. 2 AT&T stands out from the pack with a net loss last year of $1.67 billion, a result of a $6.7 billion equipment write-off. Similarly, Honeywell Inc., ranked 10th, posted a net loss of $434.9 million due to military-contract losses and restructuring. Other heavy losers include Combustion Engineering Inc., Cullinet Software Inc. (which competitor Computer Associates Inc. recently agreed to buy), LTV Corp. and Sundstrand Corp.

Lower profits mean fewer investments from retained earnings in the future. A sign of this is the five-year figures for capital outlays made from net-cash flow — a gauge of capital investment and an indicator of competitiveness. When profits go up, capital outlays go up, usually with a lag of one year. Last year was no exception. As a result of '87 profits, '88 capital outlays rose to 83.8% of net-cash flow, up from 73.9% in 1987.

That's usually a good sign. But for three years in a row, this figure has been less than 100%. As a rule of thumb, anything less than 100% implies a capital base being compromised for short-term profit. In the capital-intensive, cutthroat electronics industry, this is indeed cause for concern. And with falling profits this year, the industry can look for even smaller percentages next year.

ROI, ROE both drop

Other financial indicators give rise to concern, too. Both return on investment and return on equity declined last year. ROI at 7.2% was down from 10.2% in 1987. Similarly, ROE dropped from 14.1% in 1987 to 13.1% in 1988. Both of these figures give credence to Wall Street's opinion that electronics — especially the semiconductor field — is losing its investment appeal.

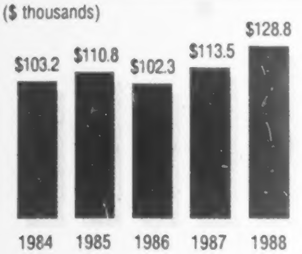
Foreign sales of the ELECTRONIC BUSINESS 200 rose 42.1%, while U.S. sales were up only 2.4%

But, of course, aggregation masks individual performance. This year's list had its share of successes. Micron Technology Inc., for example, the Idaho-based DRAM maker, came from nowhere to nab the 107th position in 1988. The company rode the DRAM shortage to capture sales of $368 million for calendar year 1988, up from $116 million in 1987.

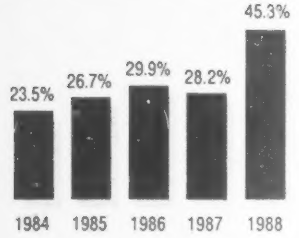
In all, this year's list has 22 new entrants. Most of these additions replaced companies that went private or were acquired. In fact, only seven of the 22 that fell off the list did so because of inadequate sales growth. Notable departures include Computervision Corp., acquired by Prime Computer Inc., itself a target of a hostile takeover bid; Convergent Inc., bought by Unisys Corp.; Gould Inc., sold to Nippon Mining Co. Ltd.; and The Singer Co., bought by corporate raider Paul Bilzerian.

Restructuring has its upside and its downside. It has meant a more productive industry, with sales per employee coming in at a strong 13.4% growth rate in 1988, up from 10.9% in 1987. But it has also meant a growing debt burden. For the ELECTRONIC BUSINESS 200, debt as a percentage of total capital shot up by 60.6% last year and is now up to a dangerous and unprecedented 45.3%. The consequences could be severe if the economy heads south later this year, as many financial experts predict. ☐

Sales/employee



Debt/total capital



Notes to the ELECTRONIC BUSINESS 200

Revenue (sales)
Revenue includes sales of products, services and rentals, but excludes dividends, interest and other non-operating revenue.

Profit
Profits are shown after taxes from continuing operations and before extraordinary items.

Return on equity
ROE is profits as a percentage of shareholders' equity (preferred stock, capital stock, surplus and retained earnings at the company's year-end).

Return on investment
ROI is profits as a percentage of shareholders' equity plus short-term debt and long-term debt. Short-term debt includes the current portion of long-term debt, notes payable and other borrowings.

Cost of goods sold
This includes manufacturing costs of products, services and rentals sold, less depreciation as a percentage of revenue.

Research and development
R&D is company-sponsored research and development expenses as a percentage of revenue.

Employees
The number of employees is supplied by each company. In most cases this number represents year-end employment.

Capital expenditures to net cash flow
Capital expenditures are measured as a percentage of net profits from continuing operations plus depreciation, minus cash dividends paid.

Debt to total capital
This includes long-term debt plus short-term debt as a percentage of shareholders' equity and long- and short-term debt.

Foreign sales
These include sales of operations outside the United States to unaffiliated customers and U.S. operations' export sales.

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES: 1-50

Rank			Calendar year 1988			Fiscal year 1988			
1988	1987	Company	Electronics revenue ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Return on equity	Return on investment
1	1	**IBM**	$59,681	$59,681.0	$5 491.0	$59,681.0	$5,491.0	13.9%	10.4%
2	2	**AT&T**	14,377	35,210.0	-1,669.0	35,210.0	-1,669.0	-14.6%	-8.1%
3	4	**Digital Equipment**	12,285	12,284.7	1,209.2	11,475.5	1,305.6	17.4%	16.8%
4	3	**GM Hughes Electronics**	11,244	11,243.6	634.6	11,243.6	634.6	8.4%	7.4%
5	7	**Xerox**[1]	11,152	11,476.0	73.0	11,476.0	73.0	6.8%	2.9%
6	8	**Hewlett-Packard**	10,296	10,296.0	830.0	9,831.0	816.0	18.0%	16.0%
7	5	**Unisys**	9,902	9.902.0	680.6	9,902.0	680.6	13.7%	8.0%
8	6	**General Electric**	9,300	40,292.0	3,386.0	40,292.0	3,386.0	18.3%	12.8%
9	9	**Motorola**	8,250	8,250.0	445.0	8,250.0	445.0	13.2%	9.4%
10	10	**Honeywell**	7,148	7,148.3	-434.9	7,148.3	-434.9	-25.1%	-15.3%
11	12	**Texas Instruments**	6,295	6,295.0	336.0	6,294.8	366.3	16.3%	12.7%
12	11	**NCR**	5,990	5,989.9	439.3	5,989.9	439.3	19.6%	16.1%
13	14	**Raytheon**	4,994	8,192.1	489.6	8,192.1	489.6	23.1%	15.9%
14	15	**Eastman Kodak**	4,830	17,034.0	1,397.0	17,034.0	1,397.0	20.6%	8.4%
15	16	**Rockwell International**	4,593	12,133.8	779.0	11,946.3	811.9	22.0%	17.5%
16	13	**Lockheed**	4,554	10,590.0	442.0	10,590.0	442.0	17.9%	12.9%
17	22	**Apple Computer**	4,434	4,434.1	419.3	4,071.4	400.3	39.9%	35.4%
18	17	**Tandy**	3,992	3,992.3	321.3	3,793.8	316.4	19.7%	15.3%
19	26	**Control Data**	3,628	3,628.3	1.7	3,628.3	1.7	0.2%	0.1%
20	24	**Ford Motor**	3,350	92,445.6	5,300.2	92,445.6	5,300.2	24.6%	5.8%
21	20	**Litton Industries**	3,326	4,942.4	172.0	4,863.9	167.0	14.2%	6.1%
22	21	**Wang Laboratories**	3,075	3,074.5	50.3	3,068.4	92.7	5.8%	4.1%
23	23	**Martin Marietta**	3,058	5,727.5	319.8	5,727.5	319.8	26.6%	18.9%
24	25	**3M**	3,000	10,581.0	1,154.0	10,581.0	1,154.0	20.9%	18.4%
25	35	**Intel**	2,875	2,874.8	452.9	2,874.8	452.9	21.8%	16.3%
26	19	**TRW**	2,842	6,982.0	261.0	6,982.0	261.0	16.7%	10.2%
27	18	**Allied-Signal**	2,750	11,909.0	463.0	11,909.0	463.0	14.2%	8.3%
28	29	**Zenith Electronics**	2,686	2,685.7	5.3	2,685.7	5.3	1.1%	0.6%
29	28	**Westinghouse Electric**	2,672	12,499.5	822.8	12,449.5	822.8	21.7%	6.5%
30	36	**National Semiconductor**	2,667	2,666.8	-18.1	2,469.7	62.7	6.2%	5.9%
31	27	**ITT**	2,539	19,355.0	858.0	19,355.0	817.0	10.2%	5.4%
32	32	**Du Pont**	2,300	32,917.0	2,190.0	32,917.0	2,190.0	14.1%	10.5%
33	34	**AMP**	2,269	2,669.7	319.1	2,699.7	319.1	21.0%	18.3%
34	33	**Boeing**	2,231	16,962.0	614.0	16,962.0	614.0	11.4%	10.8%
35	39	**Emerson Electric**	2,200	6,793.1	540.7	6,651.5	528.8	18.8%	14.5%
36	30	**Harris**	2,105	2,104.8	69.6	2,099.3	65.4	6.7%	5.8%
37	47	**Compaq Computer**	2,066	2,065.6	255.2	2,065.6	255.2	31.3%	23.4%
38	31	**Pitney Bowes**	2,020	2,649.9	237.0	2,649.9	237.0	18.7%	6.5%
39	38	**GTE**	2,000	16,459.9	1,224.7	16,460.0	1,177.0	12.4%	5.6%
40	41	**Amdahl**	1,802	1,801.8	213.8	1,801.8	213.8	21.2%	18.5%
41	37	**McDonnell Douglas**	1,800	15,072.0	350.0	15,072.0	350.0	11.0%	5.1%
42	42	**Avnet**	1,718	1,938.3	50.6	1,829.3	52.2	7.5%	5.7%
43	58	**Prime Computer**	1,595	1,594.6	13.0	1,594.6	13.0	2.4%	1.8%
44	65	**Sun Microsystems**	1,462	1,461.6	89.6	1,051.6	66.4	18.0%	12.6%
45	44	**Tektronix**	1,431	1,431.0	-8.6	1,411.9	-16.7	-3.4%	-2.3%
46	52	**Tandem Computers**	1,425	1,424.7	102.1	1,314.7	94.5	11.0%	9.5%
47	53	**Seagate Technology**	1,351	1,351.0	-5.5	1,257.0	77.3	17.7%	10.4%
48	45	**Data General**	1,331	1,330.5	-48.8	1,364.7	-15.5	-2.5%	-2.2%
49	59	**Chrysler**	1,300	31,884.2	1,050.2	31,884.2	1,050.2	13.9%	3.0%
50	54	**E-Systems**	1,298	1,439.0	74.6	1,443.1	74.6	15.2%	12.5%

NA = not available
NM = not meaningful

[1] Xerox data is for business products and systems only, except for ROE, ROI, capital expenditures to net cash flow and debt to total capital

Cost of goods as a percentage of revenue	Fiscal year 1988			Five-year growth (Compounded average annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income				
35.0%	9.9%	$154.2	$14.2	5.4%	0.0%	70.5%	25.3%	57.6%	12/88
56.5%	7.3%	115.7	-5.5	NA	NA	539.3%	44.7%	0.0%	12/88
43.1%	11.4%	91.4	10.4	21.9%	35.7%	82.8%	3.6%	49.9%	6/88
70.7%	4.9%	115.9	6.5	NA	NA	55.7%	11.9%	12.3%	12/88
43.5%	6.9%	114.6	0.7	7.5%	NA	167.7%	58.1%	49.5%	12/88
44.3%	10.4%	113.0	9.4	15.9%	13.6%	57.9%	11.1%	51.6%	10/88
49.4%	7.2%	106.5	7.3	18.2%	28.2%	60.0%	41.7%	45.8%	12/88
67.9%	3.0%	134.3	11.3	7.8%	11.1%	51.7%	30.4%	39.0%	12/88
54.5%	8.1%	80.9	4.4	13.8%	12.8%	96.5%	29.0%	48.1%	12/88
71.9%	4.5%	91.2	-5.5	11.0%	NM	-136.0%	39.2%	22.9%	12/88
70.3%	7.8%	83.2	4.8	6.6%	NM	93.9%	22.4%	32.3%	12/88
48.5%	7.0%	99.8	7.3	9.9%	8.8%	66.1%	17.9%	58.3%	12/88
76.6%	3.3%	107.5	6.4	7.8%	9.7%	68.4%	31.0%	19.0%	12/88
49.4%	6.7%	117.2	9.6	10.9%	19.8%	96.7%	59.2%	43.9%	12/88
75.5%	3.6%	106.5	7.2	8.1%	15.8%	49.7%	20.4%	21.6%	9/88
NA	5.1%	122.0	5.1	11.5%	10.9%	52.5%	27.8%	11.1%	12/88
47.0%	6.7%	377.0	37.1	32.9%	44.2%	32.9%	11.3%	32.1%	9/88
47.5%	0.0%	102.5	8.6	11.1%	3.3%	28.1%	22.3%	1.8%	6/88
64.2%	9.3%	108.3	0.1	1.3%	-58.1%	86.6%	28.5%	29.8%	12/88
63.3%	3.2%	257.6	14.8	15.8%	23.2%	59.9%	76.5%	32.7%	12/88
74.2%	4.7%	88.4	3.0	4.2%	-7.8%	64.6%	57.0%	26.9%	7/88
40.3%	8.0%	99.3	3.0	14.8%	-9.4%	79.8%	29.4%	46.2%	6/88
78.8%	3.4%	86.8	4.8	12.2%	14.6%	73.7%	28.9%	0.0%	12/88
51.7%	6.5%	127.5	13.9	8.5%	11.6%	64.4%	12.0%	40.0%	12/88
45.0%	11.1%	138.2	21.8	20.7%	31.3%	71.9%	25.1%	42.9%	12/88
74.7%	5.1%	89.6	3.3	7.6%	7.5%	81.6%	38.6%	28.6%	12/88
77.2%	5.4%	108.7	4.2	6.5%	0.7%	98.7%	41.3%	35.3%	12/88
82.3%	3.7%	74.6	0.1	14.6%	-35.2%	68.0%	45.2%	17.9%	12/88
70.3%	5.7%	104.1	6.9	5.5%	12.9%	47.3%	69.8%	19.6%	12/88
63.3%	11.3%	65.5	1.7	15.3%	NM	85.5%	3.8%	45.2%	5/88
36.8%	2.7%	165.4	7.0	-0.9%	3.9%	46.6%	46.5%	28.6%	12/88
49.3%	4.0%	233.5	15.5	2.7%	14.2%	114.0%	25.4%	51.9%	12/88
56.1%	8.8%	112.0	13.2	12.2%	14.4%	59.6%	12.9%	53.6%	12/88
84.4%	4.4%	115.2	4.2	8.8%	11.6%	73.1%	4.6%	46.3%	12/88
63.2%	3.1%	93.9	7.5	11.8%	9.9%	44.7%	22.5%	28.1%	9/88
60.5%	5.6%	92.9	2.9	3.0%	0.5%	47.9%	13.2%	15.0%	6/88
57.3%	3.6%	299.4	37.0	79.4%	150.3%	89.9%	25.2%	38.6%	12/88
27.3%	3.0%	90.4	8.1	10.8%	15.8%	93.5%	65.2%	21.0%	12/88
61.3%	1.8%	103.5	7.4	6.1%	4.4%	109.0%	54.7%	14.7%	12/88
47.5%	12.3%	217.1	25.8	18.3%	37.7%	88.4%	12.5%	43.2%	12/88
77.6%	4.0%	124.1	2.9	8.9%	1.5%	98.9%	53.2%	21.8%	12/88
73.8%	0.0%	182.9	5.2	9.4%	0.7%	38.9%	24.6%	0.0%	6/88
40.7%	10.9%	128.7	1.0	25.3%	-16.8%	80.6%	25.3%	56.6%	12/88
47.5%	13.3%	148.3	9.4	161.2%	152.0%	100.0%	29.6%	38.4%	6/88
42.8%	15.3%	87.8	-1.0	3.5%	NM	164.9%	31.9%	44.4%	5/88
30.6%	12.9%	152.4	11.0	25.7%	25.1%	102.6%	14.0%	51.0%	9/88
78.0%	4.0%	41.9	2.6	62.7%	43.9%	221.7%	41.2%	40.5%	6/88
43.1%	12.1%	88.5	-1.0	10.5%	NM	116.6%	14.1%	46.0%	9/88
78.4%	2.8%	244.8	8.1	19.2%	28.3%	82.3%	78.2%	12.9%	12/88
63.1%	NA	86.3	4.5	13.2%	6.9%	57.6%	17.8%	10.4%	12/88

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES: 51-100

Rank			Calendar year 1988			Fiscal year 1988			
1988	1987	Company	Electronics revenue ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Return on equity	Return on investment
51	50	**General Instrument**	$1,268	$1,268.3	$84.3	$1,155.5	$66.2	12.0%	9.1%
52	56	**Varian Associates**	1,193	1,193.0	54.7	1,170.6	27.6	6.2%	5.5%
53	55	**General Dynamics**	1,180	9,551.0	379.0	9,551.0	379.0	19.7%	12.5%
54	57	**Advanced Micro Devices**	1,126	1,125.9	19.3	1,125.9	19.3	3.8%	2.7%
55	61	**Loral**	1,105	1,493.4	85.2	1,440.8	74.3	17.0%	7.3%
56	49	**Northrop**	1,087	5,797.1	-30.9	5,797.1	-30.9	-3.1%	-1.5%
57	46	**Perkin-Elmer**	1,078	1,200.7	63.7	1,165.5	60.0	8.3%	6.3%
58	43	**United Technologies**	1,050	18,000.1	659.1	18,000.1	659.1	13.7%	11.4%
59	77	**Arrow Electronics**	1,006	1,006.4	9.7	1,006.4	9.7	6.6%	3.4%
60	48	**Teledyne**	989	3,532.6	391.8	3,534.6	391.8	18.3%	14.5%
61	51	**Grumman**	985	3,648.9	86.5	3,648.9	86.5	10.5%	5.0%
62	76	**Western Digital**	973	972.9	48.3	768.3	43.0	16.9%	11.4%
63	74	**Computer Associates**	925	925.3	142.4	709.1	101.8	20.4%	16.4%
64	73	**SCI Systems**	900	900.1	20.3	777.7	19.0	12.5%	5.2%
65	62	**Johnson Controls**	881	3,227.2	104.6	3,099.6	103.5	12.1%	7.9%
66	66	**Storage Technology**	874	874.0	44.2	874.0	44.2	15.6%	7.4%
67	64	**Eaton**	860	3,468.5	227.7	3,468.5	227.7	19.7%	12.2%
68	71	**Intergraph**	800	800.2	88.0	800.2	38.0	13.2%	13.1%
69	70	**General Signal**	800	1,760.2	25.2	1,760.2	25.2	5.5%	2.6%
70	67	**SmithKline Beckman**	770	4,749.0	229.2	4,749.0	229.2	14.8%	7.8%
71	68	**Cray Research**	756	756.3	156.6	756.3	156.6	23.1%	19.7%
72	63	**Emerson Radio**	722	721.7	5.3	728.8	-12.0	-15.3%	-5.1%
73	86	**Microsoft**	719	718.6	151.4	590.8	123.9	33.0%	31.3%
74	96	**Emhart**	700	2,762.5	126.6	2,762.5	126.6	13.0%	7.3%
75	78	**Apollo Computer**	654	653.5	0.2	653.5	0.2	0.1%	0.1%
76	72	**Monsanto**	647	8,293.0	591.0	8,293.0	591.0	15.6%	10.3%
77	101	**MiniScribe**	603	603.3	25.9	603.3	25.9	NA	NA
78	91	**EG&G**	600	1,406.3	68.7	1,406.3	68.7	20.7%	18.0%
79	69	**Contel**	595	2,963.7	311.6	2,964.0	312.0	19.8%	8.0%
80	105	**LPL Investment Group**	585	585.4	9.3	585.4	9.3	20.9%	1.7%
81	79	**Medtronic**	571	733.0	95.0	653.3	86.5	21.9%	19.0%
82	90	**Molex**	550	549.6	56.3	502.4	59.3	15.2%	14.9%
83	87	**Raychem**	529	1,102.7	102.8	1,094.7	125.3	17.3%	14.8%
84	81	**Scientific-Atlanta**	510	509.8	31.8	508.6	29.7	12.5%	12.3%
85	89	**Sprague Technologies**	505	504.6	13.2	504.6	13.2	4.0%	3.4%
86	108	**Marshall Industries**	495	494.5	21.7	420.4	17.6	29.0%	16.2%
87	95	**Wyse Technology**	489	488.7	-6.9	456.6	28.0	17.0%	9.9%
88	94	**Lotus Development**	469	468.5	58.9	468.5	58.9	25.4%	17.5%
89	99	**Teradyne**	462	462.3	-3.3	462.3	-3.3	-1.2%	-0.9%
90	122	**AST Research**	461	460.7	4.3	412.7	15.1	13.1%	8.1%
91	82	**Atari**	452	452.2	39.4	452.2	39.4	47.3%	22.3%
92	97	**Analog Devices**	452	452.1	41.1	439.2	38.0	11.1%	10.2%
93	109	**MAI Basic Four**	443	443.2	24.3	420.8	24.5	27.6%	8.2%
94	102	**Dover**	428	1,953.8	145.8	1,953.8	145.8	19.7%	14.7%
95	116	**Mark IV Industries**	410	569.7	22.7	403.0	17.0	18.4%	3.1%
96	107	**Nashua**	410	989.4	32.5	989.4	32.5	14.3%	10.2%
97	88	**M/A-COM**	409	409.3	16.3	424.2	18.4	8.5%	5.7%
98	126	**AVX**	409	408.9	27.6	408.9	27.6	13.2%	8.2%
99	162	**Applied Materials**	405	405.5	47.8	362.8	40.0	19.9%	18.0%
100	83	**United Telecommunications**	400	6,493.0	141.8	6,493.0	141.8	7.6%	2.5%

NA = not available
NM = not meaningful

	Fiscal year 1988			Five-year growth (Compounded average annual growth rate)					
Cost of goods as a percentage of revenue	**R&D as a percentage of revenue**	**Revenue per employee** ($ thousands)	**Net income per employee** ($ thousands)	**Revenue**	**Net income**	**Capital outlays to net cash flow after dividends**	**Debt as a percentage of total capital**	**Foreign revenue as a percentage of total revenue**	**Fiscal year ended**
67.9%	3.2%	$75.0	$4.3	4.8%	-8.7%	46.2%	24.1%	10.8%	2/88
65.7%	6.9%	99.2	2.4	10.1%	-9.1%	69.2%	9.9%	40.2%	9/88
79.2%	4.3%	92.9	3.7	6.9%	6.2%	74.7%	36.5%	16.7%	12/88
45.2%	18.5%	59.5	1.0	25.7%	-1.6%	56.7%	27.5%	18.1%	12/88
56.9%	4.5%	105.2	5.4	36.0%	22.9%	38.6%	57.2%	11.2%	3/88
NA	3.6%	130.0	-0.7	12.2%	NM	165.6%	50.5%	0.0%	12/88
51.9%	8.5%	106.2	5.5	2.8%	3.6%	94.9%	24.7%	48.7%	7/88
71.9%	5.2%	96.4	3.5	6.2%	5.2%	88.1%	16.5%	46.2%	12/88
77.7%	0.0%	362.7	3.5	12.2%	13.8%	32.5%	48.0%	0.0%	12/88
73.8%	2.2%	80.7	8.9	3.5%	5.2%	151.1%	20.9%	10.7%	12/88
87.0%	0.5%	114.0	2.7	10.1%	-4.8%	72.5%	52.2%	4.8%	12/88
66.7%	8.8%	116.7	6.5	72.6%	96.3%	50.1%	32.4%	67.3%	6/88
48.4%	11.5%	158.7	22.8	64.9%	79.4%	11.8%	19.4%	39.4%	3/88
NA	0.0%	86.7	2.1	33.6%	23.6%	110.3%	58.3%	27.4%	6/88
77.6%	1.7%	107.3	3.6	18.5%	10.9%	115.2%	35.1%	16.9%	9/88
59.2%	7.7%	102.8	5.2	-0.3%	NM	35.7%	52.6%	32.5%	12/88
69.2%	3.5%	91.4	6.0	8.4%	23.6%	66.1%	37.8%	29.6%	12/88
43.4%	11.1%	109.6	12.1	26.0%	6.9%	54.3%	0.7%	28.7%	12/88
68.5%	6.6%	92.2	1.3	2.2%	-22.4%	106.5%	52.2%	25.8%	12/88
32.7%	10.4%	114.2	5.5	10.9%	-14.0%	135.2%	47.4%	44.5%	12/88
22.2%	15.6%	144.4	29.9	34.8%	43.1%	29.5%	14.9%	34.5%	12/88
93.3%	0.0%	1,041.2	-17.1	50.3%	NM	-75.4%	66.9%	0.0%	3/88
22.3%	11.8%	211.5	44.4	63.8%	80.4%	51.2%	5.1%	47.8%	6/88
65.9%	1.5%	83.7	3.8	10.4%	8.5%	62.7%	43.8%	37.0%	12/88
51.3%	11.8%	147.0	0.1	52.0%	-55.5%	141.7%	38.9%	56.6%	12/88
52.8%	7.8%	181.7	13.0	5.7%	9.9%	60.8%	34.1%	43.1%	12/88
NA	NA	NA	NA	NA	NA	NA	NA	NA	12/88
79.2%	1.4%	56.3	2.7	8.6%	7.9%	36.6%	12.9%	7.6%	12/88
24.5%	0.0%	128.9	13.6	5.4%	13.0%	129.8%	59.9%	0.0%	12/88
60.1%	1.6%	89.9	1.4	NA	NA	15.5%	91.7%	26.9%	12/88
27.7%	8.1%	111.2	14.7	13.4%	10.6%	33.0%	13.2%	31.9%	4/88
43.9%	5.3%	85.1	10.0	23.3%	21.9%	68.5%	2.0%	71.1%	6/88
39.9%	7.7%	100.4	11.5	13.4%	32.6%	44.9%	14.6%	60.6%	6/88
65.2%	5.9%	147.6	8.6	9.3%	140.3%	25.1%	1.4%	14.0%	6/88
72.8%	5.0%	61.5	1.6	3.3%	-10.9%	80.7%	16.0%	39.3%	12/88
75.0%	0.0%	280.3	11.8	9.6%	25.3%	55.1%	44.2%	0.0%	5/88
68.3%	5.3%	109.0	6.7	73.3%	90.1%	59.5%	41.5%	24.1%	3/88
11.4%	17.9%	187.4	23.6	54.6%	33.8%	57.4%	31.0%	34.0%	12/88
50.8%	13.4%	98.4	-0.7	13.0%	NM	75.9%	21.0%	45.7%	12/88
70.1%	3.8%	229.3	8.4	100.6%	56.5%	67.9%	38.1%	20.9%	6/88
61.6%	4.7%	254.0	22.1	NA	NA	6.0%	52.9%	70.5%	12/88
37.4%	13.8%	82.1	7.1	15.5%	15.6%	63.4%	8.4%	33.2%	10/88
46.6%	2.6%	94.1	5.5	NA	NA	63.5%	70.3%	62.3%	9/88
66.0%	0.0%	95.7	7.1	14.1%	13.5%	104.7%	25.2%	15.9%	12/88
59.6%	2.3%	79.0	3.3	79.6%	78.6%	31.9%	82.9%	14.6%	2/88
64.4%	0.8%	137.2	4.5	11.8%	32.4%	61.5%	28.5%	48.7%	12/88
59.7%	5.9%	65.8	2.8	1.3%	-3.6%	58.8%	32.8%	19.6%	9/88
64.6%	2.7%	77.2	5.2	20.5%	26.0%	61.0%	38.1%	43.0%	12/88
49.8%	12.0%	205.5	22.7	28.0%	51.0%	38.5%	9.8%	55.8%	10/88
82.5%	0.0%	172.4	3.8	20.9%	-8.3%	168.5%	67.1%	0.0%	12/88

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES: 101-150

Rank 1988	Rank 1987	Company	Calendar year 1988			Fiscal year 1988			
			Electronics revenue ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Return on equity	Return on investment
101	112	**Penn Central**	$400	$1,546.5	$94.1	$1,546.5	$94.1	5.3%	4.9%
102	104	**Dynatech**	399	398.7	25.0	367.8	24.5	16.1%	12.1%
103	176	**Oracle Systems**	395	394.9	56.3	282.1	42.9	31.9%	29.3%
104	93	**LTV**	388	7,324.7	-890.6	7,324.7	-890.6	-17.2%	-17.1%
105	137	**LSI Logic**	379	378.9	23.8	378.9	23.8	7.2%	4.3%
106	103	**Diebold**	369	450.6	31.3	450.6	31.3	8.7%	8.5%
107	—	**Micron Technology**	368	367.7	121.7	300.5	98.0	34.0%	31.4%
108	121	**Westmark International**	365	365.3	10.4	365.3	10.4	4.5%	4.3%
109	110	**Dataproducts**	364	364.1	-11.4	345.2	-20.2	-10.8%	-8.5%
110	80	**Corning Glass Works**	363	2,121.5	292.4	2,121.5	210.7	13.5%	10.1%
111	118	**Eli Lilly**	360	4,069.7	761.0	4,069.7	761.0	23.6%	20.3%
112	120	**Premier Industrial**	354	571.0	68.3	535.9	64.0	22.2%	21.7%
113	124	**Micropolis**	353	353.1	-19.4	353.1	-19.4	-16.0%	-9.2%
114	111	**Polaroid**	350	1,862.9	-22.6	1,862.9	-22.6	-2.2%	-1.5%
115	—	**Reliance Electric**	344	1,303.0	27.0	1,303.0	27.0	58.7%	2.9%
116	115	**DSC Communications**	340	339.7	20.0	339.7	20.0	9.3%	6.1%
117	145	**Maxtor**	339	339.0	9.9	271.2	14.1	11.9%	6.0%
118	113	**Datapoint**	335	334.5	6.2	330.8	8.0	4.4%	2.7%
119	—	**Everex Systems**	330	329.9	14.2	266.7	10.5	11.4%	10.5%
120	114	**Augat**	321	321.0	-22.8	321.0	-22.8	-12.5%	-10.8%
121	135	**Wyle Laboratories**	318	410.9	7.8	410.9	7.8	8.3%	5.5%
122	139	**Kollmorgen**	317	344.8	14.1	344.8	14.1	15.8%	8.7%
123	147	**Applied Magnetics**	316	315.7	23.9	293.0	23.7	14.1%	11.1%
124	92	**Textron**	313	7,285.5	272.1	7,285.5	272.1	11.4%	3.3%
125	117	**Cubic**	311	363.8	14.2	364.9	12.2	10.4%	6.4%
126	190	**3Com**	310	309.9	29.3	251.9	22.5	14.4%	14.0%
127	123	**Tandon**	309	309.3	-19.9	309.3	-19.9	-21.2%	-17.7%
128	131	**Foxboro**	308	539.9	9.8	539.9	9.8	5.0%	3.4%
129	132	**Ashton-Tate**	307	307.3	47.8	307.3	47.8	20.5%	20.0%
130	—	**Novell**	307	306.7	34.6	281.2	30.4	22.4%	16.2%
131	125	**Bolt Beranek and Newman**	302	302.1	6.1	305.2	18.1	16.3%	9.0%
132	154	**Mentor Graphics**	301	300.8	33.5	300.8	33.5	15.1%	14.9%
133	—	**Audiovox**	300	320.2	0.3	320.2	0.3	0.4%	0.2%
134	146	**Pioneer-Standard**	299	299.0	7.7	254.6	5.2	15.4%	5.8%
135	136	**Watkins-Johnson**	292	292.2	20.6	292.2	20.6	15.4%	13.0%
136	119	**Genicom**	291	291.4	1.0	291.4	1.0	1.6%	0.6%
137	133	**Savin**	288	360.6	-15.1	360.6	-15.1	-26.6%	-12.3%
138	141	**Gerber Scientific**	288	288.4	31.7	264.0	29.6	17.5%	15.6%
139	127	**Square D**	282	1,656.8	118.9	1,656.8	118.9	18.7%	10.5%
140	130	**Diasonics**	282	281.6	9.8	281.6	9.8	8.4%	6.6%
141	—	**Sequa**	281	1,712.6	71.6	1,712.6	71.5	10.2%	5.2%
142	138	**CTS**	276	275.6	-2.2	275.6	-3.3	-2.8%	-2.3%
143	143	**Bell Industries**	273	430.6	12.2	431.6	12.8	11.0%	9.3%
144	142	**Cooper Industries**	270	4,258.3	224.4	4,258.3	224.4	12.7%	7.4%
145	175	**Combustion Engineering**	270	3,483.9	-245.2	3,483.9	-245.2	-41.3%	-23.8%
146	178	**Stratus Computer**	265	265.3	29.3	265.3	29.3	21.1%	19.3%
147	152	**Measurex**	265	265.2	37.1	265.2	37.1	18.1%	17.6%
148	166	**Anthem Electronics**	265	264.6	11.3	264.6	11.3	14.0%	12.3%
149	134	**Figgie International**	264	1,200.2	61.9	1,203.9	61.9	16.9%	8.8%
150	150	**Andrew**	264	263.9	13.7	253.5	13.9	8.4%	7.2%

NA = not available
NM = not meaningful

Cost of goods as a percentage of revenue	Fiscal year 1988			Five-year growth (Compounded average annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income				
58.1%	0.6%	$111.3	$6.8	-9.4%	36.7%	28.1%	8.7%	20.2%	12/88
42.6%	9.4%	120.2	8.0	22.3%	20.2%	39.5%	25.0%	28.3%	3/88
57.6%	9.1%	127.8	19.4	123.7%	130.6%	55.4%	8.1%	47.5%	5/88
82.7%	0.0%	188.8	-23.0	9.9%	NM	-63.7%	0.4%	0.0%	12/88
47.8%	9.8%	117.3	7.4	61.2%	19.1%	128.5%	40.6%	38.4%	12/88
66.8%	3.1%	98.8	6.9	0.2%	-8.6%	33.2%	1.6%	8.9%	12/88
33.4%	3.1%	134.8	43.9	87.0%	NM	35.9%	7.6%	31.4%	8/88
52.4%	10.3%	113.2	3.2	12.3%	NM	54.1%	4.0%	28.5%	12/88
69.6%	7.7%	97.3	-5.7	1.7%	NM	-72.1%	22.0%	29.4%	3/88
58.6%	4.5%	80.7	8.0	5.3%	18.0%	87.0%	24.9%	17.4%	12/88
27.8%	13.3%	158.4	29.6	8.3%	10.7%	57.4%	13.8%	37.0%	12/88
50.6%	0.5%	124.6	14.9	11.0%	15.6%	13.3%	2.3%	0.0%	5/88
87.8%	8.0%	110.4	-6.1	46.9%	NM	-1,354.1%	42.6%	69.0%	12/88
49.4%	8.0%	160.4	-1.9	8.2%	NM	661.5%	35.0%	43.7%	12/88
69.8%	0.0%	100.2	2.1	NA	NA	25.8%	95.1%	10.4%	12/88
50.0%	13.2%	122.8	7.2	11.5%	-9.9%	103.0%	34.0%	19.5%	12/88
68.2%	8.8%	86.4	4.5	NA	NA	153.0%	49.3%	16.0%	3/88
48.1%	3.5%	122.8	3.0	-9.3%	-0.2%	82.2%	38.4%	84.5%	7/88
74.7%	5.9%	166.7	6.6	NA	NA	33.0%	7.6%	11.9%	7/88
70.6%	4.1%	89.2	-6.3	6.9%	NM	-147.8%	13.6%	20.4%	12/88
75.9%	0.0%	188.9	3.6	16.0%	NM	93.0%	34.0%	0.0%	1/89
64.0%	4.2%	88.4	3.6	5.8%	9.6%	65.3%	45.0%	23.9%	12/88
67.3%	7.7%	31.0	2.5	23.6%	28.7%	137.8%	21.1%	44.7%	9/88
55.9%	2.3%	121.4	4.5	30.8%	25.1%	55.9%	71.1%	25.6%	12/88
74.6%	1.6%	96.0	3.2	6.0%	-6.7%	50.3%	38.7%	4.6%	9/88
43.2%	9.3%	186.9	16.7	121.3%	331.9%	61.7%	2.3%	27.0%	5/88
77.3%	4.4%	208.5	-13.4	0.4%	NM	-51.7%	16.8%	10.0%	12/88
58.6%	6.9%	101.9	1.9	0.3%	4.2%	67.3%	31.7%	50.9%	12/88
8.3%	17.2%	245.8	38.2	48.2%	55.4%	52.0%	2.4%	39.5%	1/89
40.6%	5.7%	177.5	19.2	118.3%	NM	40.4%	28.0%	32.4%	10/88
55.9%	4.8%	97.2	5.8	29.0%	40.7%	84.9%	44.5%	0.0%	6/88
39.7%	11.2%	176.0	19.6	63.4%	NM	62.6%	1.8%	47.8%	12/88
79.5%	0.0%	291.0	0.3	NA	NA	60.9%	44.5%	0.0%	11/88
75.2%	0.0%	292.6	6.0	16.5%	53.7%	27.5%	62.5%	0.0%	3/88
58.9%	6.3%	92.8	6.5	9.5%	3.0%	39.4%	15.4%	26.0%	12/88
67.7%	3.6%	78.9	0.3	NA	NA	87.3%	63.7%	27.6%	12/88
61.4%	1.0%	178.4	-7.5	-2.2%	-1.5%	23.4%	53.8%	11.9%	12/88
45.5%	6.5%	142.7	16.0	17.7%	45.8%	44.9%	10.6%	53.0%	4/88
62.9%	3.0%	80.8	5.8	8.7%	12.3%	66.0%	43.9%	19.8%	12/88
60.1%	7.2%	169.6	5.9	17.6%	NM	52.8%	22.0%	39.5%	12/88
70.8%	1.0%	107.0	4.5	42.6%	NM	72.8%	49.0%	30.1%	12/88
70.7%	1.6%	43.2	-0.5	5.1%	NM	49.2%	18.0%	19.4%	12/88
74.9%	0.0%	227.2	6.7	14.0%	13.4%	38.8%	15.5%	0.0%	6/88
64.6%	0.0%	92.0	4.8	18.1%	-33.4%	44.5%	41.9%	22.5%	12/88
91.1%	1.6%	120.8	-8.5	8.9%	NM	-51.6%	42.4%	39.5%	12/88
35.0%	11.5%	155.1	17.2	66.8%	68.0%	43.4%	8.5%	28.2%	12/88
49.8%	7.2%	101.2	14.1	16.7%	50.5%	23.5%	2.9%	84.5%	11/88
76.7%	0.0%	529.3	22.6	43.7%	52.7%	5.7%	12.1%	0.0%	12/88
71.0%	1.3%	69.2	3.6	13.4%	21.8%	75.7%	48.1%	0.0%	12/88
59.4%	5.6%	94.6	5.2	7.8%	-4.7%	46.1%	14.5%	53.3%	9/88

(Continued)

THE ELECTRONIC BUSINESS 200

FINANCIAL TABLES: 151-200

Rank 1988	Rank 1987	Company	Calendar year 1988 Electronics revenue ($ millions)	Calendar year 1988 Total revenue ($ millions)	Calendar year 1988 Net income ($ millions)	Fiscal year 1988 Total revenue ($ millions)	Fiscal year 1988 Net income ($ millions)	Return on equity	Return on investment
151	129	**Recognition Equipment**	$262	$261.5	-$13.1	$260.8	-$12.2	-11.0%	-6.2%
152	140	**Bally Manufacturing**	260	1,940.8	38.0	1,940.8	38.0	6.5%	1.7%
153	—	**Dell Computer**	258	257.8	14.4	257.8	14.4	19.2%	13.2%
154	—	**Conner Peripherals**	257	256.6	19.8	256.6	19.8	18.8%	15.3%
155	128	**TIE/communications**	255	255.3	-17.0	255.3	-17.0	-14.6%	-11.7%
156	148	**Reynolds and Reynolds**	250	605.4	21.9	600.1	18.1	9.0%	6.0%
157	—	**Management Science America**	250	250.0	-33.6	250.0	-33.6	-108.4%	-88.7%
158	144	**Ball**	245	1,073.0	32.7	1,073.0	32.7	7.8%	5.0%
159	—	**Vishay Intertechnology**	244	244.4	17.1	109.0	15.5	16.4%	6.9%
160	153	**BRIntec**	240	337.3	5.7	337.3	5.7	8.7%	3.8%
161	—	**Concurrent Computer**	240	239.9	-8.1	263.1	14.4	7.4%	6.5%
162	151	**Sundstrand**	239	1,477.3	-50.1	1,477.3	-50.1	-8.5%	-5.2%
163	185	**Inmac**	236	236.0	7.6	222.8	9.7	21.5%	17.0%
164	165	**Cincinnati Milacron**	233	857.8	25.0	857.8	25.0	11.0%	5.8%
165	167	**Imo Industries**	232	687.2	28.3	687.2	28.3	9.6%	4.8%
166	161	**Fluke**	232	231.6	13.0	224.5	12.4	9.4%	8.9%
167	158	**Logicon**	231	231.0	8.9	218.9	9.1	15.0%	15.0%
168	174	**Olin**	231	2,308.0	98.0	2,308.0	98.0	14.3%	7.4%
169	196	**Tyco Laboratories**	230	1,792.5	82.0	1,574.6	66.5	22.7%	10.4%
170	164	**DCA**	226	226.4	26.5	227.5	42.2	20.8%	20.8%
171	188	**VLSI Technology**	221	221.2	6.7	221.2	6.7	4.5%	2.6%
172	171	**Esterline**	216	288.5	7.9	284.4	8.4	10.3%	7.9%
173	172	**Dynascan**	214	213.8	7.2	213.8	7.2	14.6%	8.4%
174	156	**Cullinet Software**	208	207.8	-42.4	216.7	-47.0	-62.3%	-50.4%
175	187	**Cipher Data Products**	206	206.5	14.6	185.4	10.4	7.0%	6.9%
176	169	**GenRad**	206	205.9	-6.2	205.9	-6.2	-9.3%	-4.7%
177	184	**Thomas & Betts**	206	514.6	58.7	514.6	58.7	18.6%	14.5%
178	106	**AM International**	205	820.7	8.1	820.7	8.1	3.5%	1.6%
179	—	**Fairchild Industries**	205	538.7	15.5	550.4	15.5	10.8%	6.2%
180	163	**Ultimate**	204	203.9	-8.7	209.2	13.0	12.6%	11.8%
181	170	**General DataComm**	203	203.2	-11.3	192.2	-18.4	-28.8%	-18.5%
182	—	**QMS**	199	199.2	-4.4	186.7	-5.0	-8.3%	-4.7%
183	186	**Oak Industries**	198	197.8	12.9	197.8	12.9	14.0%	10.0%
184	—	**International Rectifier**	195	195.2	-11.2	178.6	-12.1	-41.5%	-6.5%
185	—	**Flextronics**	194	194.5	-1.5	146.4	5.2	12.6%	8.0%
186	179	**Sun Electric**	190	190.0	-4.2	190.0	-4.2	-5.6%	-3.5%
187	200	**Pittway**	190	771.1	37.3	771.1	37.3	11.1%	8.9%
188	189	**Coherent**	189	188.8	-0.2	188.1	-1.3	-1.6%	-1.3%
189	194	**Cherry Electrical**	186	210.9	7.4	194.6	7.4	10.4%	6.6%
190	—	**LTX**	182	182.2	-0.4	174.8	7.0	11.4%	8.5%
191	—	**Becton, Dickinson**	178	1,749.1	160.4	1,709.4	148.9	15.5%	9.0%
192	—	**Chips & Technologies**	178	177.9	25.4	141.5	22.1	33.2%	31.3%
193	—	**Burr-Brown**	177	176.7	11.5	176.7	11.5	15.1%	11.1%
194	182	**ADC Telecommunications**	175	175.3	15.6	179.9	17.0	18.1%	17.5%
195	198	**Brush Wellman**	173	345.8	32.5	345.8	32.5	14.0%	11.4%
196	181	**Quantum**	172	172.5	-2.4	188.5	-3.2	-2.8%	-2.8%
197	—	**Rexon**	171	171.2	9.9	155.5	9.0	13.1%	11.3%
198	—	**Integrated Device Technology**	170	170.4	18.0	121.1	11.6	13.4%	10.1%
199	—	**Aydin**	170	169.7	8.4	169.7	8.4	11.0%	9.2%
200	—	**Ask Computer Systems**	168	168.3	12.2	142.4	10.8	11.8%	11.4%

NA = not available
NM = not meaningful

Cost of goods as a percentage of revenue	Fiscal year 1988			Five-year growth (Compounded average annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income				
55.8%	3.3%	$96.3	-$4.5	17.4%	NM	87.5%	43.8%	56.3%	10/88
63.2%	0.7%	149.3	2.9	17.9%	NM	131.2%	74.2%	0.0%	12/88
67.7%	2.8%	214.8	12.0	NA	NA	40.0%	31.2%	15.4%	1/89
76.6%	3.4%	88.6	6.8	NA	NA	122.5%	18.6%	21.6%	12/88
64.5%	5.7%	170.2	-11.3	-4.7%	NM	-44.2%	19.9%	[illegible]	12/88
58.1%	2.1%	120.6	3.6	18.9%	8.7%	61.6%	32.7%	[illegible]	9/88
NA	23.6%	105.5	-14.2	16.3%	NM	-25.9%	18.2%	23.7%	12/88
80.8%	1.2%	151.1	4.6	3.2%	-3.6%	190.5%	35.6%	0.0%	12/88
58.8%	2.9%	NA	NA	20.9%	28.5%	4.3%	57.9%	65.1%	6/88
78.8%	1.3%	86.5	1.5	5.6%	NA	39.4%	56.3%	16.7%	12/88
46.8%	12.2%	76.3	4.2	4.2%	18.3%	72.8%	11.9%	40.4%	6/88
63.1%	7.8%	107.0	-3.6	10.2%	NM	685.0%	35.2%	24.5%	12/88
62.2%	0.0%	327.7	14.3	NA	NA	34.0%	20.9%	51.4%	7/88
72.2%	4.1%	102.5	3.0	71.9%	17.7%	66.5%	47.1%	19.2%	12/88
66.2%	1.4%	89.2	3.7	11.9%	10.1%	56.8%	49.8%	26.6%	12/88
45.8%	10.4%	93.6	5.2	5.4%	5.3%	68.2%	4.8%	33.4%	9/88
81.9%	0.9%	86.6	3.6	16.2%	15.6%	35.9%	0.0%	0.0%	3/88
72.4%	2.5%	140.7	6.0	6.2%	10.3%	85.0%	48.6%	16.9%	12/88
75.1%	0.4%	131.2	5.5	22.4%	25.4%	42.7%	53.9%	7.8%	5/88
29.7%	11.3%	158.7	29.5	59.9%	82.9%	26.5%	0.0%	22.0%	6/88
44.7%	9.6%	135.7	4.1	43.9%	NM	149.4%	42.3%	29.8%	12/88
58.5%	5.7%	94.2	2.8	8.7%	6.6%	38.2%	23.5%	40.7%	10/88
74.8%	0.9%	482.7	16.4	4.3%	-3.8%	15.8%	42.5%	2.0%	12/88
81.7%	24.2%	90.3	-19.6	20.7%	NM	-29.8%	19.2%	32.6%	4/88
65.2%	9.4%	90.2	5.1	26.6%	-1.2%	27.8%	1.6%	39.1%	6/88
38.3%	14.9%	103.0	-3.1	-1.9%	NM	119.1%	49.4%	31.3%	12/88
48.0%	3.4%	109.5	12.5	11.3%	16.1%	95.2%	22.4%	42.2%	12/88
63.6%	2.6%	108.9	1.1	5.8%	NM	108.4%	53.0%	43.2%	7/88
71.6%	2.1%	110.3	3.1	67.0%	11.3%	120.7%	42.6%	0.0%	12/88
52.2%	2.6%	283.4	17.6	39.8%	23.0%	39.3%	6.4%	33.2%	4/88
51.4%	12.1%	80.1	-7.7	17.6%	NM	-193.8%	35.6%	23.9%	9/88
71.7%	3.1%	196.3	-5.2	66.5%	NM	-500.8%	43.3%	35.0%	9/88
75.3%	1.6%	52.4	3.4	-0.5%	NM	38.9%	28.4%	15.4%	12/88
67.6%	4.3%	77.7	-5.3	15.1%	NM	-8,571.5%	84.4%	43.5%	6/88
83.2%	0.0%	52.9	1.9	82.6%	80.3%	83.6%	36.8%	59.4%	3/88
52.0%	2.8%	77.7	-1.7	4.6%	NM	347.8%	38.3%	44.0%	12/88
60.0%	2.3%	98.9	4.8	12.6%	7.2%	87.7%	20.0%	24.2%	12/88
58.7%	10.5%	110.6	-0.8	15.6%	NM	159.0%	18.0%	38.4%	9/88
62.4%	5.7%	68.7	2.6	17.3%	18.5%	92.2%	36.4%	55.9%	2/88
41.8%	18.1%	123.9	4.9	28.3%	22.8%	89.4%	25.5%	49.2%	7/88
47.1%	5.5%	83.0	7.2	10.6%	36.1%	121.6%	41.8%	37.6%	9/88
47.6%	13.2%	459.3	71.7	NA	NA	27.1%	5.7%	56.0%	6/88
39.5%	8.3%	120.1	7.9	21.8%	21.8%	83.1%	26.8%	69.1%	12/88
49.1%	9.7%	107.1	10.1	18.7%	25.4%	51.7%	3.3%	14.5%	10/88
63.4%	1.9%	132.9	12.5	10.5%	13.4%	54.6%	18.5%	24.3%	12/88
71.4%	6.4%	371.1	-6.4	35.2%	NM	28.8%	0.0%	22.0%	3/88
66.0%	4.7%	133.3	7.7	NA	NA	47.8%	13.5%	35.1%	9/88
34.8%	15.5%	91.2	8.7	NA	NA	110.8%	24.9%	20.0%	3/88
68.4%	5.0%	84.8	4.2	2.1%	-9.7%	26.8%	16.7%	19.7%	12/88
42.9%	8.3%	206.7	15.7	29.3%	22.6%	31.2%	3.5%	12.7%	6/88

(Continued)

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Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
Mainframes								
Amdahl	$217.1	11.9%	18.5%	47.5%	12.3%	15.5%	43.2%	40
IBM	154.2	9.2%	10.4%	35.0%	9.9%	9.0%	57.6%	1
Cray Research	144.4	20.7%	19.7%	22.2%	15.6%	10.8%	34.5%	71
Control Data	108.3	0.1%	0.1%	64.2%	9.3%	4.7%	29.8%	19
Unisys	106.5	6.9%	8.0%	49.4%	7.2%	6.8%	45.8%	7
NCR	99.8	7.3%	16.1%	48.5%	7.0%	7.0%	58.3%	12
Weighted average	**$139.2**	**8.5%**	**10.3%**	**39.2%**	**9.5%**	**8.6%**	**54.4%**	
Minicomputers								
Stratus Computer	$155.1	11.1%	19.3%	35.0%	11.5%	6.7%	28.2%	146
IBM	154.2	9.2%	10.4%	35.0%	9.9%	9.0%	57.6%	1
Tandem Computers	152.4	7.2%	9.5%	30.6%	12.9%	14.1%	51.0%	46
Sun Microsystems	148.3	6.3%	12.6%	47.5%	13.3%	11.2%	38.4%	44
Apollo Computer	147.0	0.0%	0.1%	51.3%	11.8%	9.2%	56.6%	75
Prime Computer	128.7	0.8%	1.8%	40.7%	10.9%	8.8%	56.6%	43
Hewlett-Packard	113.0	8.3%	16.0%	44.3%	10.4%	6.6%	51.6%	6
MAI Basic Four	94.1	5.8%	8.2%	46.6%	2.6%	3.9%	62.3%	93
Digital Equipment	91.4	11.4%	16.8%	43.1%	11.4%	13.2%	49.9%	3
Data General	88.5	-1.1%	-2.2%	43.1%	12.1%	7.1%	46.0%	48
Concurrent Computer	76.3	5.5%	6.5%	46.8%	12.2%	7.8%	40.4%	161
Weighted average	**$133.8**	**8.9%**	**11.2%**	**37.6%**	**10.3%**	**9.3%**	**55.3%**	
Microcomputers								
Apple Computer	$377.0	9.8%	35.4%	47.0%	6.7%	3.5%	32.1%	17
Compaq Computer	299.4	12.4%	23.4%	57.3%	3.6%	13.2%	38.6%	37
Atari	254.0	8.7%	22.3%	61.6%	4.7%	0.5%	70.5%	91
AST Research	229.3	3.7%	8.1%	70.1%	3.8%	3.5%	20.9%	90
Dell Computer	214.8	5.6%	13.2%	67.7%	2.8%	2.6%	15.4%	153
Tandon	208.5	-6.4%	-17.7%	77.3%	4.4%	2.6%	10.0%	127
Everex Systems	166.7	3.9%	10.5%	74.7%	5.9%	1.6%	11.9%	119
IBM	154.2	9.2%	10.4%	35.0%	9.9%	9.0%	57.6%	1
Tandy	102.5	8.3%	15.3%	47.5%	0.0%	2.5%	1.8%	18
Zenith Electronics	74.6	0.2%	0.6%	82.3%	3.7%	1.2%	17.9%	28
Weighted average	**$152.4**	**8.8%**	**11.1%**	**39.4%**	**8.7%**	**8.1%**	**50.7%**	
Computer-based systems								
Ask Computer Systems	$206.7	7.6%	11.4%	42.9%	8.3%	3.8%	12.7%	200
Mentor Graphics	176.0	11.2%	14.9%	39.7%	11.2%	9.7%	47.8%	132
Gerber Scientific	142.7	11.2%	15.6%	45.5%	6.5%	5.8%	53.0%	138
Hewlett-Packard	113.0	8.3%	16.0%	44.3%	10.4%	6.6%	51.6%	6
Coherent	110.8	-0.7%	-1.3%	58.7%	10.5%	4.8%	38.4%	188
Intergraph	109.6	11.0%	13.1%	43.4%	11.1%	8.3%	28.7%	68
Measurex	101.2	14.0%	17.6%	49.8%	7.2%	3.9%	84.5%	147
Recognition Equipment	96.3	-4.7%	-6.2%	55.8%	3.3%	3.5%	56.3%	151
Sun Electric	77.7	-2.2%	-3.5%	52.0%	2.8%	2.6%	44.0%	186
Weighted average	**$113.3**	**8.1%**	**14.4%**	**44.9%**	**10.0%**	**6.5%**	**50.0%**	

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Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	200 rank
Semiconductors								
Chips & Technologies	$459.3	15.6%	31.3%	47.6%	13.2%	4.6%	56.0%	192
Intel	138.2	15.8%	16.3%	45.0%	11.1%	16.6%	42.9%	25
VLSI Technology	135.7	3.0%	2.6%	44.7%	9.6%	24.9%	29.8%	171
Micron Technology	134.8	32.6%	31.4%	33.4%	3.1%	14.7%	31.4%	107
Burr-Brown	120.1	6.5%	11.1%	39.5%	8.3%	12.1%	69.1%	193
LSI Logic	117.3	6.3%	4.3%	47.8%	9.8%	26.6%	38.4%	105
Western Digital	116.7	5.6%	11.4%	66.7%	8.8%	4.7%	67.3%	62
Integrated Device Technology	91.2	9.6%	10.1%	34.8%	15.5%	23.0%	20.0%	198
Texas Instruments	83.2	5.8%	12.7%	70.3%	7.8%	10.0%	32.3%	11
Analog Devices	82.1	8.6%	10.2%	37.4%	13.8%	10.8%	33.2%	92
Motorola	80.9	5.4%	9.4%	54.5%	8.1%	10.6%	48.1%	9
International Rectifier	77.7	-6.8%	-6.5%	67.6%	4.3%	7.2%	43.5%	184
National Semiconductor	65.5	2.5%	5.9%	63.3%	11.3%	8.1%	45.2%	30
Advanced Micro Devices	59.5	1.7%	2.7%	45.2%	18.5%	8.7%	18.1%	54
Weighted average	**$84.9**	**6.7%**	**10.9%**	**57.5%**	**9.4%**	**11.1%**	**41.4%**	
Capital equipment								
Applied Materials	$205.5	11.0%	18.0%	49.8%	12.0%	5.5%	55.8%	99
Gerber Scientific	142.7	11.2%	15.6%	45.5%	6.5%	5.8%	53.0%	138
LTX	123.9	4.0%	8.5%	41.8%	18.1%	10.3%	49.2%	190
Hewlett-Packard	113.0	8.3%	16.0%	44.3%	10.4%	6.6%	51.6%	6
Perkin-Elmer	106.2	5.1%	6.3%	51.9%	8.5%	7.2%	48.7%	57
GenRad	103.0	-3.0%	-4.7%	38.3%	14.9%	6.0%	31.3%	176
Varian Associates	99.2	2.4%	5.5%	65.7%	6.9%	3.7%	40.2%	52
Teradyne	98.4	-0.7%	-0.9%	50.8%	13.4%	4.3%	45.7%	89
Esterline	94.2	2.9%	7.9%	58.5%	5.7%	2.3%	40.7%	172
Fluke	93.6	5.5%	8.9%	45.8%	10.4%	7.0%	33.4%	166
Tektronix	87.8	-1.2%	-2.3%	42.8%	15.3%	5.5%	44.4%	45
Sun Electric	77.7	-2.2%	-3.5%	52.0%	2.8%	2.6%	44.0%	186
Weighted average	**$108.3**	**6.2%**	**11.2%**	**46.9%**	**10.4%**	**6.1%**	**49.0%**	
Peripherals								
Quantum	$371.1	-1.7%	-2.8%	71.4%	6.4%	1.6%	22.0%	196
AST Research	229.3	3.7%	8.1%	70.1%	3.8%	3.5%	20.9%	90
QMS	196.3	-2.7%	-4.7%	71.7%	3.1%	2.0%	35.0%	182
Everex Systems	166.7	3.9%	10.5%	74.7%	5.9%	1.6%	11.9%	119
Rexon	133.3	5.8%	11.3%	66.0%	4.7%	3.5%	35.1%	197
Micropolis	110.4	-5.5%	-9.2%	87.8%	8.0%	18.1%	69.0%	113
Wyse Technology	109.0	6.1%	9.9%	68.3%	5.3%	4.6%	24.1%	87
Storage Technology	102.8	5.1%	7.4%	59.2%	7.7%	5.4%	32.5%	66
Dataproducts	97.3	-5.9%	-8.5%	69.6%	7.7%	2.1%	29.4%	109
Cipher Data Products	90.2	5.6%	6.9%	65.2%	9.4%	2.5%	39.1%	175
Conner Peripherals	88.6	7.7%	15.3%	76.6%	3.4%	11.8%	21.6%	154
Maxtor	86.4	5.2%	6.0%	68.2%	8.8%	14.1%	16.0%	117
Genicom	78.9	0.3%	0.6%	67.7%	3.6%	4.2%	27.6%	136
Seagate Technology	41.9	6.2%	10.4%	78.0%	4.0%	22.6%	40.5%	47
Applied Magnetics	31.0	8.1%	11.1%	67.3%	7.7%	18.9%	44.7%	123
Weighted average	**$75.6**	**3.5%**	**5.8%**	**71.0%**	**5.8%**	**10.3%**	**33.0%**	

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Fiscal 1988 figures **Company**	**Revenue per employee** ($ thousands)	**Profit as a percentage of revenue**	**Return on investment**	**Cost of goods sold as a percentage of revenue**	**R&D as a percentage of revenue**	**Capital expenditures as a percentage of revenue**	**Foreign revenue as a percentage of revenue**	**200 rank**
Software								
Ultimate	$283.4	6.2%	11.8%	52.2%	2.6%	4.2%	33.2%	180
Ashton-Tate	245.8	15.5%	20.0%	8.3%	17.2%	11.8%	39.5%	129
Microsoft	211.5	21.0%	31.3%	22.3%	11.8%	12.1%	47.8%	73
Lotus Development	187.4	12.6%	17.5%	11.4%	17.9%	11.8%	34.0%	88
Computer Associates	158.7	14.4%	16.4%	48.4%	11.5%	2.7%	39.4%	63
Oracle Systems	127.8	15.2%	29.3%	57.6%	9.1%	11.0%	47.5%	103
Management Science America	105.5	-13.4%	-88.7%	-4.8%	23.6%	2.2%	23.7%	157
Cullinet Software	90.3	-21.7%	-50.4%	81.7%	24.2%	3.2%	32.6%	174
Weighted average	**$162.0**	**10.1%**	**15.5%**	**32.7%**	**14.2%**	**7.7%**	**38.7%**	
Communications								
Dynascan	$482.7	3.4%	8.4%	74.8%	0.9%	0.7%	2.0%	173
Inmac	327.7	4.4%	17.0%	62.2%	0.0%	1.7%	51.4%	163
3Com	186.9	8.9%	14.0%	43.2%	9.3%	7.5%	27.0%	126
Novell	177.5	10.8%	16.2%	40.6%	5.7%	5.5%	32.4%	130
TIE/communications	170.2	-6.6%	-11.7%	64.5%	5.7%	1.9%	30.0%	155
DCA	158.7	18.6%	20.8%	29.7%	11.3%	6.0%	22.0%	170
Scientific-Atlanta	147.6	5.8%	12.3%	65.2%	5.9%	2.0%	14.0%	84
Datapoint	122.8	2.4%	2.7%	48.1%	3.5%	5.9%	84.5%	118
DSC Communications	122.8	5.9%	6.1%	50.0%	13.2%	13.5%	19.5%	116
Dynatech	120.2	6.7%	12.1%	42.6%	9.4%	4.1%	28.3%	102
ADC Telecommunications	107.1	9.4%	17.5%	49.1%	9.7%	7.5%	14.5%	194
Bolt Beranek and Newman	97.2	5.9%	9.0%	55.9%	4.8%	9.4%	0.0%	131
Andrew	94.6	5.5%	7.2%	59.4%	5.6%	5.1%	53.3%	150
Motorola	80.9	5.4%	9.4%	54.5%	8.1%	10.6%	48.1%	9
General DataComm	80.1	-9.6%	-18.5%	51.4%	12.1%	4.5%	23.9%	181
General Instrument	75.0	5.7%	9.1%	67.9%	3.2%	5.2%	10.8%	51
Weighted average	**$91.2**	**5.4%**	**9.0%**	**55.2%**	**7.3%**	**8.6%**	**39.2%**	
Consumer								
Emerson Radio	$1,041.2	-1.6%	-5.1%	93.3%	0.0%	0.9%	0.0%	72
Audiovox	291.0	0.1%	0.2%	79.5%	0.0%	0.3%	0.0%	133
Tandy	102.5	8.3%	15.3%	47.5%	0.0%	2.5%	1.8%	18
Zenith Electronics	74.6	0.2%	0.6%	82.3%	3.7%	1.2%	17.9%	28
Weighted average	**$100.6**	**4.1%**	**9.3%**	**65.7%**	**1.3%**	**1.8%**	**7.3%**	
Office equipment								
Savin	$178.4	-4.2%	-12.3%	61.4%	1.0%	0.3%	11.9%	137
IBM	154.2	9.2%	10.4%	35.0%	9.9%	9.0%	57.6%	1
Xerox	114.6	0.6%	0.5%	43.5%	6.9%	4.4%	49.5%	5
NCR	99.8	7.3%	16.1%	48.5%	7.0%	7.0%	58.3%	12
Wang Laboratories	99.3	3.0%	4.1%	40.3%	8.0%	8.9%	46.2%	22
Diebold	98.8	7.0%	8.5%	66.8%	3.1%	1.8%	8.9%	106
Harris	92.9	3.1%	5.8%	60.5%	5.6%	3.9%	15.0%	36
Pitney Bowes	90.4	8.9%	6.5%	27.3%	3.0%	11.7%	21.0%	38
Weighted average	**$134.7**	**7.5%**	**8.4%**	**37.9%**	**8.9%**	**8.2%**	**53.5%**	

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Government								
GM Hughes Electronics	$115.9	5.6%	7.4%	70.7%	4.9%	4.7%	12.3%	4
Loral	105.2	5.2%	7.3%	56.9%	4.5%	3.5%	11.2%	55
Varian Associates	99.2	2.4%	5.5%	65.7%	6.9%	3.7%	40.2%	52
Cubic	96.0	3.4%	6.4%	74.6%	1.6%	2.7%	4.6%	125
Harris	92.9	3.1%	5.8%	60.5%	5.6%	3.9%	15.0%	36
Watkins-Johnson	92.8	7.0%	13.0%	58.9%	6.3%	4.0%	26.0%	135
Honeywell	91.2	-6.1%	-15.3%	71.9%	4.5%	4.6%	22.9%	10
Litton Industries	88.4	3.4%	6.1%	74.2%	4.7%	4.7%	26.9%	21
SCI Systems	86.7	2.4%	5.2%	-2.6%	0.0%	5.5%	27.4%	64
Logicon	86.6	4.1%	15.0%	81.9%	0.9%	1.7%	0.0%	167
E-Systems	86.3	5.2%	12.5%	63.1%	NA	3.7%	10.4%	50
Aydin	84.8	4.9%	9.2%	68.4%	5.0%	2.1%	19.7%	199
Texas Instruments	83.2	5.8%	12.7%	70.3%	7.8%	10.0%	32.3%	11
Motorola	80.9	5.4%	9.4%	54.5%	8.1%	10.6%	48.1%	9
M/A-COM	65.8	4.3%	5.7%	59.7%	5.9%	5.5%	19.6%	97
Weighted average	**$92.4**	**3.3%**	**5.7%**	**65.7%**	**6.2%**	**6.3%**	**25.7%**	
Medical								
Diasonics	$169.6	3.5%	6.6%	60.1%	7.2%	3.7%	39.5%	140
Westmark International	113.2	2.9%	4.3%	52.4%	10.3%	3.1%	28.5%	108
Medtronic	111.2	13.2%	19.0%	27.7%	8.1%	5.1%	31.9%	81
Weighted average	**$120.8**	**8.2%**	**12.6%**	**41.7%**	**8.6%**	**4.3%**	**32.6%**	
Components								
AMP	$112.0	11.8%	18.3%	56.1%	8.8%	8.2%	53.6%	33
LPL Investment Group	89.9	1.6%	1.7%	60.1%	1.6%	1.2%	26.9%	80
Augat	89.2	-7.1%	-10.8%	70.6%	4.1%	5.5%	20.4%	120
BRIntec	86.5	1.7%	3.8%	78.8%	1.3%	1.5%	16.7%	160
Molex	85.1	11.8%	14.9%	43.9%	5.3%	13.7%	71.1%	82
AVX	77.2	6.7%	8.2%	64.6%	2.7%	8.0%	43.0%	98
Cherry Electrical	68.7	3.8%	6.6%	62.4%	5.7%	9.1%	55.9%	189
Sprague Technologies	61.5	2.6%	3.4%	72.8%	5.0%	7.6%	39.3%	85
Oak Industries	52.4	6.5%	10.0%	75.3%	1.6%	3.8%	15.4%	183
CTS	43.2	-1.2%	-2.3%	70.7%	1.6%	3.6%	19.4%	142
Vishay Intertechnology	NA	14.2%	6.9%	58.8%	2.9%	0.8%	65.1%	159
Weighted average	**$87.0**	**7.2%**	**10.2%**	**61.0%**	**5.7%**	**6.9%**	**44.4%**	
Distribution								
Anthem Electronics	$529.3	4.3%	12.3%	76.7%	0.0%	0.3%	0.0%	148
Arrow Electronics	362.7	1.0%	3.4%	77.7%	0.0%	0.5%	0.0%	59
Pioneer-Standard	292.6	2.0%	5.8%	75.2%	0.0%	0.8%	0.0%	134
Marshall Industries	280.3	4.2%	16.2%	75.0%	0.0%	2.6%	0.0%	86
Wyle Laboratories	188.9	1.9%	5.5%	75.9%	0.0%	2.3%	0.0%	121
Avnet	182.9	2.9%	5.7%	73.8%	0.0%	1.4%	0.0%	42
Weighted average	**$234.9**	**2.5%**	**6.3%**	**75.3%**	**0.0%**	**1.3%**	**0.0%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

THE ELECTRONIC BUSINESS 200

BEST AND WORST PERFORMERS

Net income/sales

(percentage)		200 rank
TOP 10		
Micron Technology	32.6%	107
Microsoft	21.0%	73
Cray Research	20.7%	71
Eli Lilly	18.7%	111
Digital Communications	18.6%	170
Intel	15.8%	25
Chips & Technologies	15.6%	192
Ashton-Tate	15.5%	129
Oracle Systems	15.2%	103
Computer Associates	14.4%	63
MEDIAN	**4.9%**	
BOTTOM 5		
Augat	-7.1%	120
General DataComm	-9.6%	181
LTV	-12.2%	104
MSA	-13.4%	157
Cullinet Software	-21.7%	174

Sales per employee

($ thousands)		200 rank
TOP 10		
Emerson Radio	$1,041.2	72
Anthem Electronics	529.3	148
Dynascan	482.7	173
Chips & Technologies	459.3	192
Apple Computer	377.0	17
Quantum	371.1	196
Arrow Electronics	362.7	59
Inmac	327.7	163
Compaq Computer	299.4	37
Pioneer-Standard	292.6	134
MEDIAN	**$109.5**	
BOTTOM 5		
Flextronics	$52.9	185
Oak Industries	52.4	183
CTS	43.2	142
Seagate Technology	41.9	47
Applied Magnetics	31.0	123

Five-year net income growth

(compound average annual)		200 rank
TOP 10		
3Com	331.9%	126
Sun Microsystems	152.0%	44
Compaq Computer	150.3%	37
Scientific-Atlanta	140.3%	84
Oracle Systems	130.6%	103
Western Digital	96.3%	62
Wyse Technology	90.1%	87
Digital Communications	82.9%	170
Microsoft	80.4%	73
Flextronics	80.3%	185
MEDIAN	**9.6%**	
BOTTOM 5		
General Signal	-22.4%	69
Cooper Industries	-33.4%	144
Zenith Electronics	-35.2%	28
Apollo Computer	-55.5%	75
Control Data	-58.1%	19

Return on equity

(percentage)		200 rank
TOP 10		
Reliance Electric	58.7%	115
Atari	47.3%	91
Apple Computer	39.9%	17
Micron Technology	34.0%	107
Chips & Technologies	33.2%	192
Microsoft	33.0%	73
Oracle Systems	31.9%	103
Compaq Computer	31.3%	37
Marshall Industries	29.0%	85
MAI Basic Four	27.6%	93
MEDIAN	**13.2%**	
BOTTOM 5		
General DataComm	-28.8%	181
Combustion Engineering	-41.3%	145
International Rectifier	-41.5%	184
Cullinet Software	-62.3%	174
MSA	-108.4%	157

Net income per employee

($ thousands)		200 rank
TOP 10		
Chips & Technologies	$71.7	192
Microsoft	44.4	73
Micron Technology	43.9	107
Ashton-Tate	38.2	129
Apple Computer	37.1	17
Compaq Computer	37.0	37
Cray Research	29.9	71
Eli Lilly	29.6	111
Digital Communications	29.5	170
Amdahl	25.8	40
MEDIAN	**$5.2**	
BOTTOM 5		
Tandon	-$13.4	127
MSA	-14.2	157
Emerson Radio	-17.1	72
Cullinet Software	-19.6	174
LTV	-23.0	104

Debt/total capital

(percentage)		200 rank
TOP 10		
Reliance Electric	95.1%	115
LPL Investment Group	91.7%	80
International Rectifier	84.4%	184
Mark IV Industries	82.9%	95
Chrysler	78.2%	49
Ford Motor	76.5%	20
Bally Manufacturing	74.2%	152
Textron	71.1%	124
MAI Basic Four	70.3%	93
Westinghouse Electric	69.8%	29
MEDIAN	**28.5%**	
BOTTOM 5		
Intergraph	0.7%	68
LTV	0.4%	104
Quantum	0.0%	196
Digital Communications	0.0%	170
Logicon	0.0%	167

Return on investment

(percentage)		200 rank
TOP 10		
Apple Computer	35.4%	17
Micron Technology	31.4%	107
Microsoft	31.3%	73
Chips & Technologies	31.3%	192
Oracle Systems	29.3%	103
Compaq Computer	23.4%	37
Atari	22.3%	91
Premier Industrial	21.7%	112
Digital Communications	20.8%	170
Eli Lilly	20.3%	111
MEDIAN	**8.2%**	
BOTTOM 5		
Tandon	-17.7%	127
General DataComm	-18.5%	181
Combustion Engineering	-23.8%	145
Cullinet Software	-50.4%	174
MSA	-88.7%	157

Five-year revenue growth

(compound average annual)		200 rank
TOP 10		
Sun Microsystems	161.2%	44
Oracle Systems	123.7%	103
3Com	121.3%	126
Novell	118.3%	130
AST Research	100.6%	90
Micron Technology	87.0%	107
Flextronics	82.6%	185
Mark IV Industries	79.6%	95
Compaq Computer	79.4%	37
Wyse Technology	73.3%	87
MEDIAN	**12.4%**	
BOTTOM 5		
GenRad	-1.9%	176
Savin	-2.2%	137
TIE/communications	-4.7%	155
Datapoint	-9.3%	118
Penn Central	-9.4%	101

Foreign revenue/total revenue

(percentage)		200 rank
TOP 10		
Datapoint	84.5%	118
Measurex	84.5%	147
Molex	71.1%	82
Atari	70.5%	91
Burr-Brown	69.1%	193
Micropolis	69.0%	113
Western Digital	67.3%	62
Vishay Intertechnology	65.1%	159
MAI Basic Four	62.3%	93
Raychem	60.6%	83
MEDIAN	**32.3%**	
BOTTOM 5		
EG&G	7.6%	78
Grumman	4.8%	61
Cubic	4.6%	125
Dynascan	2.0%	173
Tandy	1.8%	18

THE ELECTRONIC BUSINESS 200

ARRIVALS AND DEPARTURES

ARRIVALS	1988 rank
Ask Computer Systems	200
Audiovox	133
Becton, Dickinson	191
Burr-Brown	193
Chips & Technologies	192
Concurrent Computer	161
Dell Computer	153
Fairchild Industries	179
Flextronics	185
Genicom	136
Integrated Device Technology	198
International Rectifier	184
LTX	190
Management Science America	157
Micron Technology	107
Novell	130
QMS	182
Reliance Electric	115
Rexon	197
Sequa	141
Vishay Intertechnology	159

DEPARTURES	1987 rank
Altos Computer Systems	192
Ametek	177
Avantek	155
Bell & Howell[1]	168
Burndy[2]	183
Compugraphic[3]	100
Computervision[4]	75
Convergent[5]	98
Decision Industries[6]	173
Gencorp	195
Gould[7]	60
ISC Systems[8]	180
Insilco[9]	199
Intelligent Systems	193
Micom Systems[10]	157
NBI	191
Paradyne[11]	149
Singer[12]	40
Tyler	84
United Industrial	197
Veeco Instruments[13]	159
Xidex[14]	85

[1] acquired by the Bass Group May 17, 1988

[2] acquired by Frametome SA Jan. 10, 1989

[3] merged with Agfa-Gevaert Inc., a unit of Bayer AG June 15, 1988

[4] acquired by Prime Computer Inc. (rank 43) Feb. 5, 1988

[5] acquired by Unisys Corp. (rank 7) Dec. 22, 1988

[6] acquired by Onset Corp. April 29, 1988

[7] acquired by Nippon Mining Co. Nov.1, 1988

[8] acquired by Ing. C. Olivetti & Co. SpA May 5, 1989

[9] acquired by INR Acquisition Corp., a unit of Wagner & Brown Sept. 29, 1988

[10] acquired by Odyssey Partners Sept. 15, 1988

[11] acquired by American Telephone & Telegraph Co. Jan. 8, 1989

[12] acquired by Bilzerian Partners L.P.1 April 19, 1988

[13] acquired by VII Merger Corp. a unit of Unitech Plc Feb. 22, 1989

[14] acquired by Anacomp Inc. Aug. 29, 1988

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THE ELECTRONIC BUSINESS 200

ALPHABETICAL INDEX

Company	Rank
ADC Telecommunications Inc.	194
AM International Inc.	178
AMP Inc.	33
AST Research Inc.	90
AT&T	2
AVX Corp.	98
Advanced Micro Devices Inc.	54
Allied-Signal Inc.	27
Amdahl Corp.	40
Analog Devices Inc.	92
Andrew Corp.	150
Anthem Electronics Inc.	148
Apollo Computer Inc.	75
Apple Computer Inc.	17
Applied Magnetics Corp.	123
Applied Materials Inc.	99
Arrow Electronics Inc.	59
Ashton-Tate Corp.	129
Ask Computer Systems Inc.	200
Atari Corp.	91
Audiovox Corp.	133
Augat Inc.	120
Avnet Inc.	42
Aydin Corp.	199
BRIntec Corp.	160
Ball Corp.	158
Bally Manufacturing Corp.	152
Becton, Dickinson & Co.	191
Bell Industries Inc.	143
Boeing Co., The	34
Bolt Beranek and Newman Inc.	131
Brush Wellman Inc.	195
Burr-Brown Corp.	193
CTS Corp.	142
Cherry Electrical Products Corp.	189
Chips & Technologies Inc.	192
Chrysler Corp.	49
Cincinnati Milacron Inc.	164
Cipher Data Products Inc.	175
Coherent Inc.	188
Combustion Engineering Inc.	145
Compaq Computer Corp.	37
Computer Associates International Inc.	63
Concurrent Computer Corp.	161
Conner Peripherals Inc.	154
Contel Corp.	79
Control Data Corp.	19
Cooper Industries Inc.	144
Corning Glass Works	110
Cray Research Inc.	71
Cubic Corp.	125
Cullinet Software Inc.	174
DSC Communications Corp.	116
Data General Corp.	48
Datapoint Corp.	118
Dataproducts Corp.	109
Dell Computer Corp.	153
Diasonics Inc.	140
Diebold Inc.	106
Digital Communications Associates Inc.	170
Digital Equipment Corp.	3
Dover Corp.	94
DuPont, E.I.de Nemours & Co.	32
Dynascan Corp.	173
Dynatech Corp.	102
E-Systems Inc.	50
EG&G Inc.	78

Company	Rank
Eastman Kodak Co.	14
Eaton Corp.	67
Eli Lilly and Co.	111
Emerson Electric Co.	35
Emerson Radio Corp.	72
Emhart Corp.	74
Esterline Corp.	172
Everex Systems	119
Fairchild Industries Inc.	179
Figgie International Inc.	149
Flextronics Inc.	185
Fluke Mfg. Co. Inc., John	166
Ford Motor Co.	20
Foxboro Co., The	128
GM Hughes Electronics Corp.	4
GTE Corp.	39
GenRad Inc.	176
General DataComm Industries Inc.	181
General Dynamics Corp.	53
General Electric Co.	8
General Instrument Corp.	51
General Signal Corp.	69
Genicom Corp.	136
Gerber Scientific Inc.	138
Grumman Corp.	61
Harris Corp.	36
Hewlett-Packard Co.	6
Honeywell Inc.	10
IBM Corp.	1
ITT Corp.	31
Imo Industries Inc.	165
Inmac Corp.	163
Integrated Device Technology Inc.	198
Intel Corp.	25
Intergraph Corp.	68
International Rectifier Corp.	184
Johnson Controls Inc.	65
Kollmorgen Corp.	122
LPL Investment Group Inc.	80
LSI Logic Corp.	105
LTV Corp.	104
LTX Corp.	190
Litton Industries Inc.	21
Lockheed Corp.	16
Logicon Inc.	167
Loral Corp.	55
Lotus Development Corp.	88
M/A-COM Inc.	97
MAI Basic Four Inc.	93
Management Science America Inc.	157
Mark IV Industries Inc.	95
Marshall Industries	86
Martin Marietta Corp.	23
Maxtor Corp.	117
McDonnell Douglas Corp.	41
Measurex Corp.	147
Medtronic Inc.	81
Mentor Graphics Corp.	132
Micron Technology Inc.	107
Micropolis Corp.	113
Microsoft Corp.	73
MiniScribe Corp.	77
Minnesota Mining & Manufacturing Co.	24
Molex Inc.	82
Monsanto Co.	76
Motorola Inc.	9

Company	Rank
NCR Corp.	12
Nashua Corp.	96
National Semiconductor Corp.	30
Northrop Corp.	56
Novell Inc.	130
Oak Industries Inc.	183
Olin Corp.	168
Oracle Systems Corp.	103
Penn Central Corp.	101
Perkin-Elmer Corp., The	57
Pioneer-Standard Electronics Inc.	134
Pitney Bowes Inc.	38
Pittway Corp.	187
Polaroid Corp.	114
Premier Industrial Corp.	112
Prime Computer Inc.	43
QMS Inc.	182
Quantum Corp.	196
Raychem Corp.	83
Raytheon Co.	13
Recognition Equipment Inc.	151
Reliance Electric	115
Rexon Inc.	197
Reynolds and Reynolds Co., The	156
Rockwell International Corp.	15
SCI Systems Inc.	64
Savin Corp.	137
Scientific-Atlanta Inc.	84
Seagate Technology	47
Sequa Inc.	141
SmithKline Beckman Corp.	70
Sprague Technologies Inc.	85
Square D Co.	139
Storage Technology Corp.	66
Stratus Computer Inc.	146
Sun Electric Corp.	186
Sun Microsystems Inc.	44
Sundstrand Corp.	162
TIE/communications Inc.	155
TRW Inc.	26
Tandem Computers Inc.	46
Tandon Corp.	127
Tandy Corp.	18
Tektronix Inc.	45
Teledyne Inc.	60
Teradyne Inc.	89
Texas Instruments Inc.	11
Textron Inc.	124
Thomas & Betts Corp.	177
3Com Corp.	126
Tyco Laboratories Inc.	169
Ultimate Corp., The	180
Unisys Corp.	7
United Technologies Corp.	58
United Telecommunications Inc.	100
VLSI Technology Inc.	171
Varian Associates Inc.	52
Vishay Intertechnology Inc.	159
Wang Laboratories Inc.	22
Watkins-Johnson Co.	135
Western Digital Corp.	62
Westinghouse Electric Corp.	29
Westmark International Inc.	108
Wyle Laboratories Inc.	121
Wyse Technology	87
Xerox Corp.	5
Zenith Electronics Corp.	28

The "new" Amphenol: Will it exist tomorrow?

Can the "sleeping giant" outlast a disruptive reorganization and faltering image to remain a connector leader? President Martin Loeffler thinks so

BY BARBARA N. BERKMAN

Amphenol Corp. president Martin Loeffler is casting quizzical looks at the bloated horsefly buzzing around his head. Nestled in a booth at a local lunch spot set in a commercial development near headquarters in suburban Wallingford, Conn., Loeffler displays an alarming ambivalence to the fly now bashing against the window behind his head.

Another man would crush the intruder; Loeffler, a gentle and affable Austria native who has led connector-maker Amphenol the last two years, will wait for it to disappear. There is none of the competitive blood lust expected of an executive running a company in a critical period of transition.

"Amphenol intends to solidify its position as the No. 2 world supplier. It means they have to be very assertive and aggressive to hold that position," notes Kenneth Fleck, president of market researcher Fleck Telesis Inc. in Huntington Beach, Calif.

Dogged by price erosion and a blitz of mergers and acquisitions, connector makers are struggling to hold market share. But as more original equipment manufacturers whittle down their vendor lists, Loeffler's competitors are posed to carve that market share out of Amphenol's hide. Already, Amphenol's $467 million position is threatened by "the third- to seventh-ranked firms [that] all have very high ambitions to be the second world-ranked leader," adds Fleck.

Amphenol's Martin Loeffler, president, left, and Allan Dickson, director of marketing: Tending to Amphenol's shaky image

Martin Cooke

But fierce competition isn't Amphenol's only problem. Since diversified technology company Allied Corp. (now Allied-Signal Inc.) spun off Amphenol in a leveraged buyout in June 1987, the company has struggled to convince customers that it would not be sold piecemeal for assets by the purchaser, an investor group from outside the connector industry. Customers, alienated by Amphenol's shaky image, also have been put off by the company's willingness to raise prices in areas where they are the market leaders.

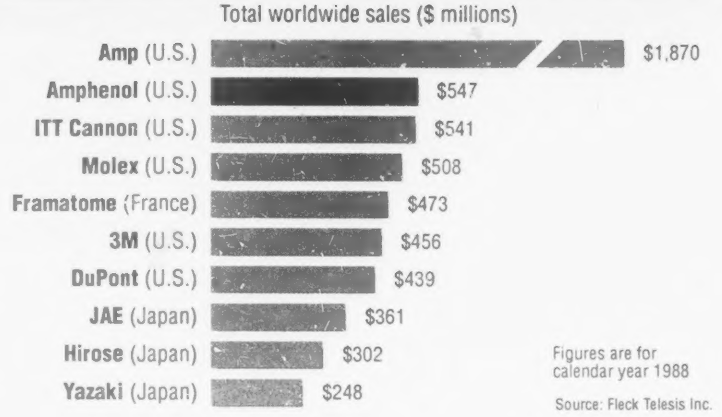
"Their biggest challenge is to hold market share because their pricing is higher," says Marian Mortfeld, product manager for Amphenol's radio frequency connector line at distributor Aztech Electronics Inc. in Columbia, Md.

Difficult goals

The change in pricing structures is only one of many at Amphenol, which is struggling to become the low-cost producer by improving lead and delivery times, quality and global market share. Exacerbated by extreme pricing pressures on connectors, the goals are difficult ones. For now, Loeffler has been only partially successful in meeting them.

Even that is an improvement for Amphenol, once "the industry sleeping giant," says Stephen Balog, a financial analyst with Shearson Lehman Hutton Inc. "They've gone through the trauma mode, a difficult but extremely important period. Now they've invigorated the growth rate

1988 top worldwide connector makers



Figures are for calendar year 1988

Source: Fleck Telesis Inc.

by focusing on what they do well."

Loeffler's strategy has been to restructure Amphenol — decentralize its direct salesforce, increase its reliance on manufacturing representatives, and shift responsibility for distributors from central headquarters to Amphenol's core divisions: fiber optics, interconnect systems and industrial technology connectors. He also is emphasizing product development — he expects to generate 10% of 1989 sales from new products alone — and is increasing its global presence through foreign joint ventures and expansion of international manufacturing facilities.

By financial measures, Loeffler's results have been good. With 1988 revenue of $467 million, Amphenol sales improved in 1988 by 7.2% over 1987. While under the industry average, when Amphenol was acquired it was just breaking even. The post-acquisition period is the first in seven years that Amphenol has performed within budget. By year-end 1988, Amphenol was showing a 15% return on sales before interest and taxes, the highest in the company's history, according to Loeffler. (In comparison, about 20% of U.S. suppliers perform at a 15% ROS, estimates Fleck.)

Amphenol, a dominant force in the worldwide military market, claims it commands through its Bendix line a hefty 22% market share. Approximately 34% of Amphenol's revenue is generated by Bendix, whose licenses were acquired by Amphenol in 1982. Its other major lines are radio frequency (RF) connectors, also known as coaxial connectors, and flat-ribbon and cable connectors, marketed under the "Spectra-Strip" name. Amphenol says it has a 15% share of the worldwide market for RF connectors, and 20% of the domestic market for cable.

But Amphenol is not the industry price leader, and some say that will hamper its effort to gain market share. Industry leader AMP Inc. "had a significant price decrease in April, and others have been flat. Nobody else has been raising prices drastically," says Charles Patteson, materials manager with Amphenol distributor Hamilton/Avnet in Dallas.

Amphenol has shown it is willing to raise prices, usually by 4% to 6% yearly. But strapped with $53 million in post-LBO interest payments in 1988, its capital resources still trail far behind those of AMP, the worldwide leader with sales of $2.7 billion last year. Clustered with Amphenol are a number of well-capitalized connector makers: ITT Cannon, Molex Inc. and 3M Co., all with 1988 revenue of $450 million to $550 million.

Amphenol itself has been victim of a larger trend in the connector industry: consolidation prompted by high costs and overhead and inferior manufacturing automation. An unprofitable division of Allied, Amphenol was spun off as one of the more than 50 connector makers that were merged or acquired in 1987 and 1988.

Amphenol has struggled to convince customers that it will not be sold piecemeal

Image problems

In a price-sensitive industry where market share spins on customer loyalty, Amphenol is grappling with an image problem with customers who conjectured the company would be stripped for assets. Loeffler says that 80 companies showed interest in buying Amphenol, then a $500 million division, from Allied; 10 went through the due diligence process.

"There were asset strippers, conglomerates who already had business in the connector industry, and there were electronics concerns who were not yet in the industry but wanted to be there," recalls Loeffler. The highest bidder at $430 million and the assumption of $100 million in debt was the LPL Investment Group Inc., which already owned Times Fiber Communications and Times Microwave Systems. A 4-year-old M&A partnership, LPL is headed by Lawrence J. DeGeorge.

An outsider to the clubbish connector industry, DeGeorge is a decisive septuagenarian with an icy penchant for slashing operating costs. It was DeGeorge who moved headquarters from Lisle, Ill., to Connecticut — slicing the corporate staff from 160-odd employees to about 16 in the process.

DeGeorge's chopping block manner has led some to dub him the Frank Lorenzo of the connector industry. "People thought Amphenol would be gobbled up and spit out by this investment group in parts. Now they're starting to realize it's a drawn-out, long-term process," says Allan Dickson, director of marketing. Some customers and distributors, however, still wait for the prophecy to be fulfilled. Says Hamilton/Avnet's Patteson: "It couldn't have been for a long-term investment. Who the hell in their 70s makes a long-term investment?"

Others agreed. "If something happened in an Amphenol division — a division or two had a bad fall — LPL would dump them, too. It's like there was a chopping block up there," says Tom Peters, corporate commodity manager at Wang Laboratories Inc. "The LPL status of a holding company running a manufacturing company is good financial business but not totally good business."

Amphenol has perpetuated misconception by acting slowly to disseminate information; one customer criticized the supplier for printing a brochure on the "new" Amphenol only seven months ago. And upper management's road shows to garner customer support is a tedious battle. Many saw leadtimes lengthen, quality falter and distribution become chaotic during the reorganization. Explains Ronald Pols, a senior buyer for Northern Telecom Ltd. in Belleville, Ontario: "We were in a wait-and-see pattern, especially when it came to long-term contracts; should we have a relationship or not? Will Amphenol be around next year?"

Amphenol and its competitors

(1988 fiscal year figures)	Amphenol	AMP	Molex
Sales ($ millions)	$467*	$2,670	$502
Sales growth (from 1987)	+7.2%	+15.0%	+29.9%
Operating income ($ millions)	$48	$530	$102
Operating income/sales	10.4%	19.8%	20.3%
Pre-tax return on sales	15.0%	19.8%	20.5%
International sales/sales	33%	54%	71%
Capital expenditures/sales	4.0%	8.2%	13.7%
R&D/sales	5.0%	8.9%	5.4%
Selling, general and administrative expenditures/sales	14.0%	17.4%	27.4%

* Excludes revenue of affiliates and joint ventures

Source: Company reports

Because Amphenol derives 34% of its revenue from the military, its R&D costs and capital expenditures are typically lower than those of competitors in the commercial connector arena.

The DeGeorge factor

As Shearson analyst Balog notes, "massive internal changes cause some dislocation at the client level." But the severity of Amphenol's image problem isn't lost on Loeffler, an unassuming man who on this day sports a company tie emblazoned with "AMPHENOL." Loeffler is an Amphenol veteran who already has outlasted the two-year stints of a succession of presidents who preceded him. Whereas Loeffler is a connector industry insider, DeGeorge is a master of restructuring. DeGeorge "understands the business and is not an outsider to it. He is an enormous problem solver. It was the best thing to have happened to Amphenol to get it out of its lethargy," says Loeffler.

Perhaps so. Under new management, there has been a complete turnaround in two Amphenol divisions that were bleeding cash heavily before LPL bought them. With domestic sales of $6 million, the Fiber Optics group lost roughly $5 million in income yearly. Amphenol's French operations broke even on sales of $3.5 million yearly. LPL put both divisions on the auction block, fueling speculation that Amphenol would be sliced for its assets.

At the same time, though, DeGeorge slashed operating costs, eliminating the cash pouring into the Fiber Optics group's R&D work on optical integrated circuits. Flooded with expensive "research tools and Ph.D.s," recalls Dickson, the group "was a paperless office with no profits and overhead of $5 million." Both divisions now are pulling in average profits, relative to the company's 19 profit centers.

The two divisions weren't the only operations to feel DeGeorge's hand. After the LBO, Amphenol decentralized operations, a restructuring that Loeffler says took $30 million out of selling and administrative costs by eliminating operational layers.

Loeffler attributes a 10% increase in domestic sales to the reorganization. Under Allied, a centralized force pitched some 500,000 part numbers. With responsibility for a broad range of products, sales reps were hard pressed to work with customers at the design phase. "Our salesforce was just geared up to make a quick shot at the customer and get a quick sale," admits Loeffler. Sales to OEMs, now 54%, were diminishing quickly, "the clearest indication of a non-innovative company," says Dickson.

Amphenol's Bendix line claims a hefty 22% of the worldwide military connector business

At a decentralized Amphenol, a customer could be approached by representatives from each of six product lines. Amphenol also expanded its 50-member direct salesforce with some 250 manufacturing reps. For big accounts, Amphenol appointed 25 key account managers worldwide to maintain their access to broad product lines.

Decentralization was meant to cut the organizational layers in the path to the customer. But once implemented, it left customers in turmoil. "Right after the acquisition, it was a nightmare. You never knew who to call, where they were, and they didn't know what was happening," recalls distributor Aztech's Mortfeld. After about six months, service and delivery times improved, she adds.

Analogous with Wang

The experiences at Wang were similar. "Things fell apart. It was very uncomfortable and unproductive doing business with Amphenol. We started looking at other companies with a one-person [sales] focus," says Wang's Peters.

"We kept talking with them and telling them we needed a person with a central focus to talk to Wang," he adds. For about nine months, Wang and Amphenol quibbled until Amphenol assigned a key account manager to the Lowell, Mass., company. Meanwhile, Amphenol slipped from Wang's No. 2 connector supplier to No. 6, says Peters. (Amphenol says it sold Wang $1.4 million of products in 1985, increased business to $3.4 million in 1987, with sales down to $2.4 million in 1988, partly because of Wang's decreased sales.)

Loeffler responds that during the reorganization, Wang was almost a test case in learning to sell to big accounts. "It took us longer to realize. Other accounts didn't feel the same as Wang. We used that as a model for the rest to implement key account management."

Amphenol's pricing, however, may yet negate the company's efforts to improve customer service: customers still consider its products pricier than the competition's. Northern Telecom reports that because some Amphenol parts can be 15% more than competitors', Amphenol "lost ground to price," says Pols.

Distributors also say Amphenol is inflexible in pricing for certain parts. Loeffler defends his distributor price structure: "They just want to get an order, but we have to give up margin, not the distributor. And that would not be a win-win situation."

"If the leader doesn't increase prices where we are strong, if we don't lead the market in some of the pricing issues, we'll just have the continued erosion of prices," he adds.

On other fronts, Amphenol is changing how it brings products to the market. To reduce total product cost, Amphenol is rationalizing "where we should source products to make us the lowest-cost producer from a global standpoint," says Loeffler. Amphenol has plowed 7.2% of revenue into capital expenditures, largely for CAD, automated assembly machinery and statistical process control, into its seven operating units in North America.

Internationally, Amphenol's product cost reduction strategy has been to build smaller, more flexible facilities of 30,000 to 50,000 square feet, replacing the 100,000 to 200,000 square-foot plants of Amphenol's past. Says Dickson: "With the fluctuation in the dollar, we're going to all types of exotic places. You can't have one great big plant in York, Pa., supplying all over. We need the flexibilty to move with our customers." To capitalize on lower manufacturing costs, for example, Amphenol recently shifted production from Taiwan to Thailand.

Amphenol also is weighing plans for a unified Europe in 1992, acting now "or risk losing significant market share," says Dickson. Last year, 33.1% of revenue was foreign. Amphenol may build a major facility overseas, and is fishing for agreements with multinational technology leaders.

Loeffler says improvements in production include:

- A 40% reduction in new product introduction time
- A 20%-to-60% reduction in cycle times, depending on product line
- A 33% reduction in leadtimes in the RF division
- A 50% reduction in leadtimes in German and British operations. By year-end, Loeffler expects Amphenol to cut company-wide leadtimes by one-half, and again by another 20% by 1990. On-time delivery, now 60%, should hit 85% by year-end, and 90% by 1990.

Overall, customers and distributors give high marks to good leadtimes and product introductions for the RF and Spectra-Strip lines. "RF has improved tremendously. They're more receptive, there are new products, and better delivery," says distributor Aztech's Mortfeld.

David Goforth, a vice president for connector marketing with distributor Sterling Electronics Corp. in Dallas, says that after the reorganization its sales from Amphenol, once flat, increased by 11%. "We've done very well on the Amphenol line."

At the industrial technology division, "We were less than satisfied, but they've made the fixes. We've got to start seeing the results," says Terry Diedrich, a marketing vice president at Dallas-based distributor Hall-Mark Electronics Corp. "It was poor a while back. Can I give them a good rating yet? Nope."

Amphenol's pricing practices may yet negate the company's efforts to improve customer service

At Bendix, leadtimes rocketed to 18 to 20 weeks in 1988 as Amphenol consolidated operations. They are now down to eight to 12 weeks for military products, and six to eight weeks for commercial lines.

Arthur Nanos, president and chief executive of Powell Electronics Inc., a Philadelphia distributor that derives one-third of its revenue from Bendix, says "delivery has improved. Quality had some problems but is now improving." Amphenol's challenge now, he adds, is "to place emphasis on new products." (Amphenol is investing in two important military products: the composite connector, for which Loeffler estimates there exists an $8 million market worldwide, and the brush connector, a $6 million market. Amphenol faces stiff competition for both these products.)

Amphenol is trying to hook customers with improved worldwide JIT and ship-to-stock in the military and aerospace market. Loeffler's goal is to become a low-cost supplier by reaching four-week leadtimes and delivering 95% on time.

Loeffler also is trying to woo customers with new products. In 1987, Amphenol generated 7% of revenue from new products introduced during the past two years, a figure Loeffler expects will jump to 10% in 1989. The company hasn't increased its R&D budget — 5% of sales — since the LBO. Instead, it reallocated to product development 3.5% of revenue realized from lowering manufacturing costs. By modifying manufacturing methods and adding CAD, Loeffler says product introduction times have been sliced in half, down from one to two years.

To fill in target niches in its product line, Amphenol will use a $1 billion credit line from LPL for acquisitions of companies sized at about $150 million to $300 million in revenue. In June, LPL announced the $62.5 million purchase of two connector groups from BRIntec Corp. Acquisitions should patch some holes in the company's commercial product offerings. "Amphenol hasn't done well on commercial product lines. It spent $20 million on 'me-too' products and lost $1 million in sales. We have strengths in several niches, with $200 million in commercial market sales," says Loeffler. The company is particularly weak in I/O connectors and high-density IDC connectors, he says.

Some in the industry, however, are skeptical of Amphenol's R&D effort. "I rarely see Amphenol in our new products," says Pols of Northern Telecom. "When it comes to product innovation, it's hard to compete against AMP and DuPont."

"They lost their technology edge with the LPL acquisition," adds Wang's Peters. "It took them some time to get it back. The visibility is not there." Loeffler responds that because of the company's weakness in the board business, customers might not see new products there until Amphenol makes an acquisition.

After a rough two-year transition, Amphenol might be on the mend. President Loeffler will need all the aggressiveness he can muster against the competition and to convince customers the "new" Amphenol has arrived. "From a procurement point of view," says Northern Telecom's Pols, "the dust hasn't settled." ☐

Electronics financiers prefer to play it safe

The news is bad for entrepreneurs seeking early- or middle-stage funding, as LBO-minded venture capitalists focus on less risky, mature companies

BY RAY WISE

Venture capital has been bitten by the leveraged buyout (LBO) bug, and that is bad news for electronics entrepreneurs who are seeking early- or middle-stage financing.

Stung by declining investment returns on their earlier stage deals, some venture capitalists have turned to backing established high-tech companies as a way to reduce risk and speed paybacks. The shift coincides with the growing recognition that solidly profitable electronics ventures can be financed prudently with debt. Thus the two forces have spurred the use of "leveraged venture capital," the electronics industry's version of the leveraged buyout.

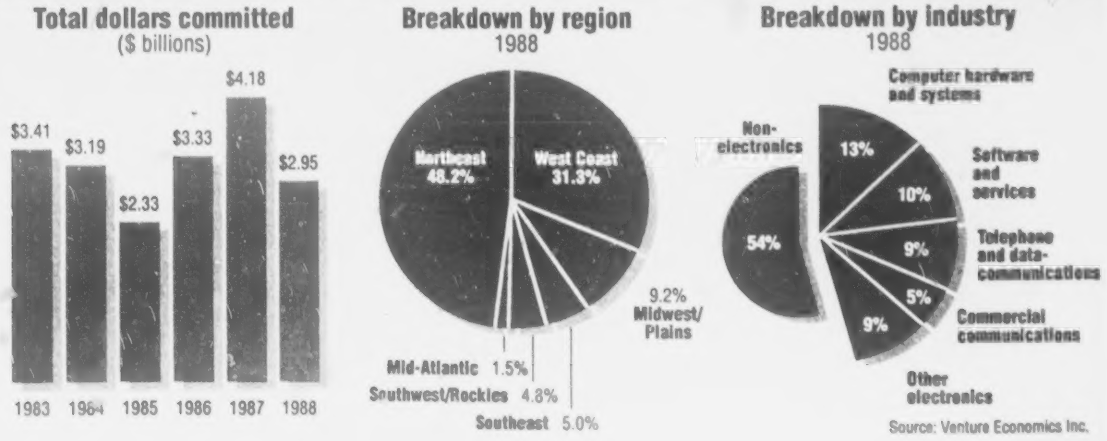
"LBO financing is increasing," says Lindsay Jones, an editor at Venture Economics Inc. in Needham, Mass. Industry statistics now being compiled by the publishing and research firm are likely to show a clear, two-year uptrend in leveraged buyout deals that include venture capital participation. About 24% of the newest fund of Hambro International Venture Fund in New York City, with a $30 million, 20 company portfolio, consists of LBOs, compared with well under 10% a couple of years ago, says Edwin A. Goodman, managing partner.

In September 1988, Hambro financed 80% of a $6 million buyout of Avatar Corp., Hopkinton, Mass., a 7-year-old supplier of connectivity products seeking to expand its share of the Macintosh-to-mainframe market. The management team of Thomas F. Bogan, president of Avatar, led the buyout of the company from a Dutch investment firm, Oranje Nassau Groep in The Hague, and put up 20% of the deal. The financing was roughly half equity, half debt, which is a lot of leverage by high-tech standards, but piddling in the LBO world, where 80% or 90% debt financing is commonplace.

What is typical about the transaction is that Avatar is a turnaround situation, which often sparks corporate restructuring. Having weathered a sea of troubles, the company, under Bogan, turned profitable in late 1987 for the first time and is profitable now. Revenue is forecast to reach $10 million this year.

Yet Avatar differs markedly from the companies that traditionally have been targeted for LBOs by the financial community — moderately growing companies with prosaic product lines and torrential, predictable cash flow, the food and tobacco blend of the RJR Nabisco deal being a textbook case. Unlike the Wall Street financiers who pull off the big buyouts that drive the stock market, venture capitalists understand high-tech and are not cowed by it. Some of them challenge the conventional view that leading-edge companies should not

Venture capital: How much is available and where it is going



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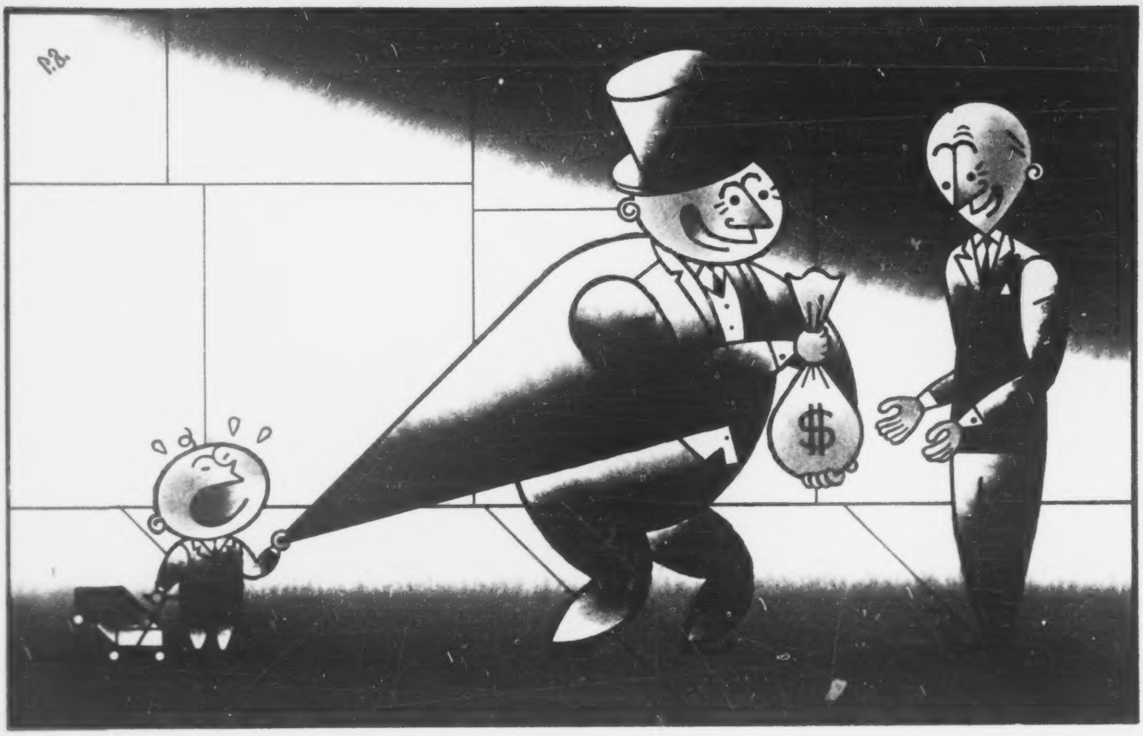

Philip Anderson

be heavily leveraged. They say debt is acceptable as long as corporate cash flow can service it and there is enough left over to support R&D and the marketing push.

Bypassing equity markets

The stock market's shabby treatment of high tech makes leverage cheaper than ever. "The LBO is a way to bypass the equity markets," says DuBose Montgomery, a general partner in Menlo Ventures, Menlo Park, Calif., who points out that a company taken out by an LBO eventually can be sold to another LBO team. This process works fine until interest rates go through the roof. Meanwhile, its victims are young high-tech companies trying to get off the ground, says Fred M. Haney, senior vice president of 3i Ventures Corp., Newport Beach, Calif. "The LBO is draining capital from early-stage companies," Haney says.

Middle-stage ventures may be the hardest hit. While many venture funds are dedicated and committed to early-stage deals or mezzanine funding, few specialize in second-and third-round financing. Moreover, some venture capitalists say middle-stage deals are much costlier than start-ups without being significantly less risky.

Data on venture capital's portfolio performance is hard to come by, but Hambro's Goodman figures the industry's annual investment returns have tumbled to single-digit levels from 20% to 25% in the 1970-1980 period. One contributor to the erosion of performance is the current tendency of entrepreneurs to stay under the wings of their venture capitalists longer, like adult children who still live with their parents because they can't afford their own housing. The venture capital nurturing cycle has expanded from three to five years in heady 1983 to five to seven years now, according to Mark L. Radtke, vice president of Advent International Corp. in Boston.

The stock market's treatment of high tech makes leverage cheaper than ever

Intense competition in parts of the high-tech marketplace causes some emerging companies to fall a year or two behind their business plan targets. The problem is greatest, according to Haney, among manufacturers of disk drives, laptops, personal computers, printers, peripherals and telecommunications products. "These are pretty crowded places. Companies have to work harder and longer to get to profitability."

High-tech entrepreneurs also must work harder and longer to go public, reflecting the poor pricing, extreme selectivity and shrinkage of the initial public offering market, which brought out only 36 venture-backed companies in 1988. This is down sharply from 81 in 1987 and 121 during the 1983 boom. In contrast, acquisitions of venture-backed companies nearly tripled to 135 in 1988 from only 49 in 1983. Stephen Woodsum, managing partner of Summit Partners in Boston, estimates that recently nearly half of Summit's portfolio companies exit via mergers and acquisitions.

Financially, the M&A route can be highly rewarding to the electronics entrepreneur. "A company worth $100 million in the public market would bring $200 million in a sale," says Arthur Spinner, a Hambro general partner. Among the reasons why market forces do not close the gap are the "control premiums" buyers are willing to pay for a company's reins, and the irreducible cost of purchasing its fixed assets and people. It takes $35 million, just for openers, to finance a semiconductor supplier, says Goodman; a selling venture capitalist would demand at least five times that amount.

Yet some entrepreneurs would readily settle for a smaller payoff to keep control of their firms. "By going public, the entrepreneur gains all the advantages. Being public creates credibility with customers. It says the company is going to be around for a while," says Michael Dolbec, associate partner in Kleiner Perkins Caufield & Byers, Palo Alto, Calif.

The stretching out of the venture capital holding period is typified by Banyan Systems Inc. of Westboro, Mass. This 6-year-old company is still private, although revenue in the first three months of fiscal 1989, ended March 31, was just under $20 million and earnings in the quarter soared 174%. The supplier of network operating system software and hardware announced this March its sixth round of private financing, structured with subordinated notes and warrants to buy common stock. Given its age, strong financials and painstaking preparation, Banyan stands a good chance of being well received when it finally does go public. "I have spent the last two and a half years educating the financial community to make sure the company is well understood," says David C. Mahoney, Banyan's president and chief executive officer.

While high-tech companies linger longer in the portfolios of venture firms, the firms take heat from institutional investors clamoring for faster returns. After all, no one is paid until the emerging company goes public or sells out. To get around this problem, some venture capitalists focus more and more on later-stage financing, even if they don't do LBOs. "It's very rough to find patient money," says Goodman.

Not only does the shift to more mature firms drain capital from younger companies, it also absorbs management time at the venture firms. "We used to spend one-third of our time looking at first-round deals. Now it's down to one-quarter," says Mike Shanahan, partner in Eastech Management Company Ltd., Boston. Shanahan worries that a slowdown in IPOs might produce a chain reaction by robbing would-be entrepreneurs of their role models. He points out that newly public companies can inspire salaried engineers and scientists to think about launching their own ventures. "They say to themselves, 'If he did it, so can I, and I might make $5 million,' " Shanahan says.

In addition, high-tech salaries have climbed high enough to function as gold handcuffs, keeping even the most ambitious and creative individuals chained to their jobs. Six-digit earners, formerly a rarity, now are so common that several are to be found among the 20-odd companies in the Eastech portfolio.

Despite dismal conditions in the IPO market, a few venture-backed companies have been going public. One such company is Goal Systems International Inc. of Columbus, Ohio, a portfolio company of Advent International in Boston and a supplier of mainframe software. Goal came out in early May, helped by awesome financials showing earnings of 60 cents a share, on revenue of $52.2 million in fiscal 1989 ended last January 31. This compares with 28 cents a share on revenue of $13.3 million in fiscal 1985.

> **Some entrepreneurs would settle for a smaller payoff to keep control of their firms**

Equally impressive is the balance sheet, which, adjusted for the IPO, lists total assets of $76.1 million, working capital of $39.9 million and stockholders' equity of $47.6 million. "That was a 'lay-up,' and you don't find many lay-ups these days," says Patrick J. Sansonetti, a senior partner of Advent and one of the venture capitalists evincing heightened interest in LBOs and other later-stage financings.

Corporate partnering

Younger, less seasoned companies, meanwhile, that are stalled on their way to the public securities market are coming up with ingenious ways of snaring dollars and reducing the financial pressure on their venture capitalists. One method of gaining rapid acceptance is corporate partnering, in which the venture sells a small piece of itself to a deep-pocketed big brother in a technology transfer or marketing rights deal.

Advent's Radtke, a former Venture Economics staffer, reports that the number of such arrangements swelled from 219 in 1983 to 477 in 1987 and says that 1988 probably saw yet another increase. The partnering trend parallels the internationalization of the electronics and venture capitalist industries, as evidenced by a transaction completed in April by a Hambro portfolio company. Goodman reports that Mathsoft Inc. of Cambridge, Mass., signed a distribution agreement with a division of C. Itoh, a major Japanese trading firm.

At the same time, venture firms that are sticking with high-tech and sticking with early-stage deals — some of the nondedicated funds have diversified into other industries such as specialty retailing — have altered their strategies to fit the tougher marketplace. For example, 3i Ventures increasingly focuses on syndicated financing of early-stage deals, in part to assure help with later-stage rounds.

3i Ventures has gone it alone in the past, only to experience difficulty obtaining back up later on, senior vice president Haney reports; so the strategy now is to bring in co-investors, even in very small transactions, to enhance 3i's marketing and technological know-how as well as its financial resources.

Kleiner Perkins devotes more time than ever before to early-stage deals and stays very close to the entrepreneurs who enter its fold. Some of the would-be CEOs are even given office space and secretarial services in Kleiner Perkins' Palo Alto, Calif., office, where they undergo a sort of incubation period. They receive help networking into product distribution and other assistance. "They can walk down the hall and ask advice," says associate partner Dolbec, stressing

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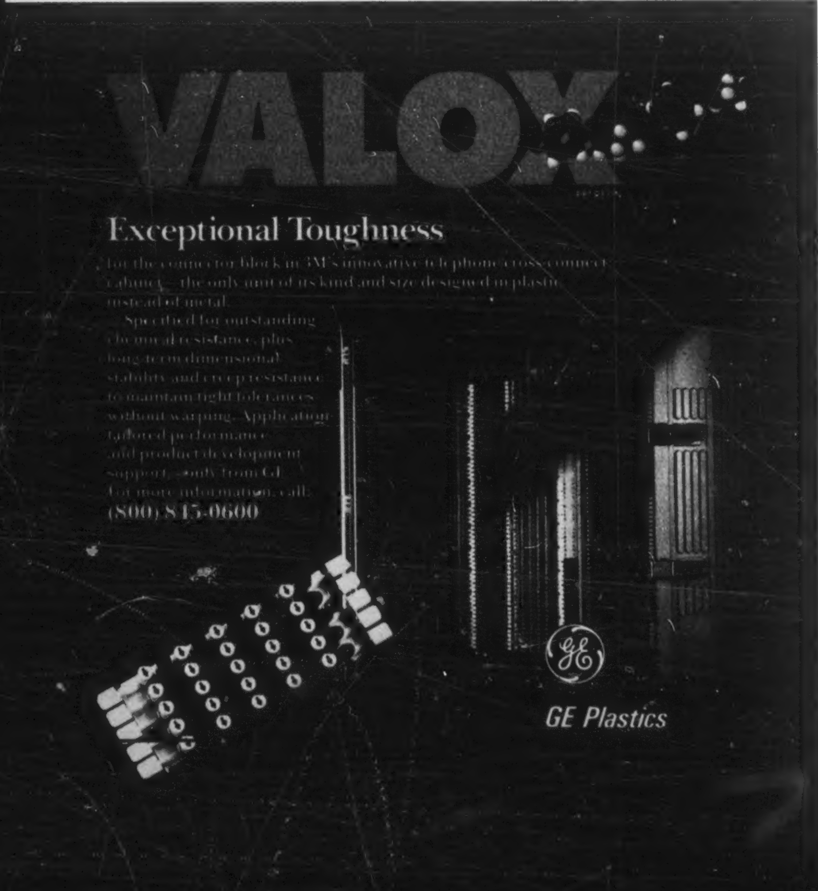

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that this is value added by the venture firm. "Anybody can just write a check."

Early-stage financiers increasingly are applying rigorous standards to the products and entrepreneurs they back. They look for quantum improvements in price performance and tenfold enhancements, because if they settle for less, the technology soon will be topped by some other venture firm's entrepreneur. Anything that the Japanese are good at is an almost automatic turnoff.

Moreover, notes Tom Stark, vice president in the Boston office of 3i Ventures, "The hardware business is going to be difficult to fund unless the product is really unique." Stark likes industrial automation, which has been toned down considerably from its early preoccupation with robotics and now focuses on automation of manufacturing and processing. Thus, 3i Ventures invested more than $2 million in five start-up and early-stage IA companies in the first three months of 1989.

Entrepreneurs are being scrutinized by venture capital firms in terms of their personal characteristics

Highly favored by Michael Moritz, partner in Sequoia Capital, Menlo Park, Calif., is the networking business, which he views as a wave that venture capital can ride almost indefinitely. He also likes the programmable logic market. "We are as busy as ever in the early-stage financing, looking at exciting and interesting propositions. We also are active in the later-stage area," Moritz reports.

Despite intense rivalry in the hardware marketplace, Dolbec of Kleiner Perkins is enthusiastic about portable, easy-to-use computers, which he sees as the wave of the future.

Other criteria also affect a company's chances of receiving the gold seal of approval from venture capitalists. Warburg Pincus Ventures Inc., New York City, sizes up high-tech funding deals in terms of management, markets and technology, in that order, on the grounds that there is a lot more technology available than there are entrepreneurs able to market it successfully. Also, "A venture can improve its chances of being funded by including international expansion in its business plan, along with corporate partnering," says Radtke of Advent.

Entrepreneurs are being closely scrutinized by venture capital firms in terms of their personal characteristics. Spinner of Hambro looks for leadership potential, good communication skills, and the ability to move comfortably in international circles. He wants a CEO who can smoothly give a presentation to 600 security analysts and bowl them over.

Given the perils of investing in high-tech, one worry might be that it eventually will be abandoned by the venture capital industry. But Goodman of Hambro is reassuring on this point, stressing that his firm will uphold its commitment to technology while seeking to boost its investment returns by injecting capital into other industries. If for no other reason than that, three of Hambro's four most profitable investments have been high-tech companies: Corporate Software Inc., Westwood, Mass.; Komag Inc., Milpitas, Calif.; and Telematics International Inc., Fort Lauderdale, Fla.

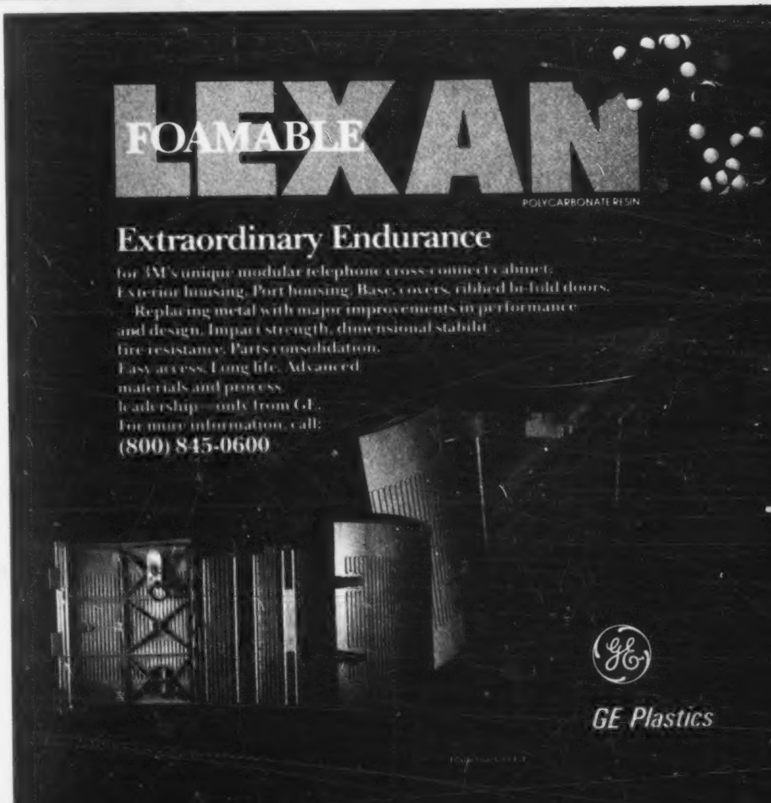
Shanahan stresses that the best thing for venture capital and the high-tech companies it supports would be a turnaround in the IPO market. Moritz says this is already happening, thanks to the recent climb in equity prices generally. "The nightmares of the last year or so have been forgotten in the current jubilation," Moritz says.

Somewhat less optimistic about the near-term outlook for the stock market and for the venture capital industry is Montgomery of Menlo Ventures, who hopes for a restoration of favorable tax treatment of capital gains as a strong stimulant to high-tech share prices.

Individual investors, historically technology's most loyal supporters, would be lured back to the stock market in droves if the tax change were enacted, Montgomery predicts. He doubts that his industry's near-term trials are over, but his longer-term view is highly positive, encompassing "a resurgence of venture capital and its return to strong profitablity." ☐

"PERCEPTION IS ALL THERE IS."

Electronic Business



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Who's who in venture capital

Results of the ELECTRONIC BUSINESS survey of venture capitalists that serve the electronics industry

Company/address	Contact	Telephone	Total paid-in capital ($ millions)	1988 figures Dollar investment ($ millions)		Number of companies invested in:	
				Total	Electronics	Total	Electronics
Accel Partners 1 Palmer Square, Princeton, N.J. 08542		(609) 683-4500	NA	NA	NA	NA	NA
Adler & Company 375 Park Avenue, Suite 3303, New York, N.Y. 10152		(212) 759-2800	NA	NA	NA	NA	NA
Advent International Corp. 101 Federal St., Boston, Mass. 02110	Thomas H. Lauer	(617) 951-9400	$400	$75	$28	60	14
Asset Management 2275 E. Bayshore Rd., Suite 150, Palo Alto, Calif. 94303	Tony Di Bona	(415) 494-7400	$72	$46	$17	56	21
BancBoston Capital Inc. 100 Federal St., Boston, Mass. 02110	Frederick M. Fritz	(617) 434-2509	$300	NA	NA	100	NA
BancBoston Ventures Inc. 100 Federal St., Boston, Mass. 02215	Jeffrey W. Wilson	(617) 434-2442	NA	$29	$7	35	10
Battery Ventures 200 Portland St., Boston, Mass. 02114	Richard D. Frisbie	(617) 367-1011	$76	$10	$10	12	12
Brentwood Associates 11661 San Vicente Blvd., Suite 707, Los Angeles, Calif. 90049	G. Bradford Jones	(213) 826-6581	$433	$39	$16	39	15
Charter Venture Capital 525 University Ave., Suite 1500, Palo Alto, Calif. 94301	A. Barr Dolan	(415) 325-6953	NA	NA	NA	50	25
Chatham Venture Corp. 420 Bedford St., Lexington, Mass. 02173	Euan C. Malcolmson David F. Millet	(617) 863-0970	$23	$14	$14	12	12
Citicorp Venture Capital Ltd. 153 E. 53rd St., 28th floor, New York, N.Y. 10043	Thomas C. Darling	(212) 559-1239	NA	NA	NA	54	27
Cornerstone Ventures 2420 Sand Hill Road, Suite 202, Menlo Park, Calif. 94025	Barbara Anderson	(415) 854-2576	$37	$20	$4	53	1
Crosspoint Venture Partners One First St., Los Altos, Calif. 94022	William P. Cargile	(415) 948-8300	$120	$64	$42	48	31
Dajen Consulting Corp. 9 Lundy Lane, Larchmont, N.Y. 10538	Robert Cohen	(914) 834-5910	NA	NA	NA	NA	NA
Dougery, Jones and Wilder 2003 Landings Drive, Mountain View, Calif. 94043	John R. Dougery	(415) 968-4820	$130	$60	$42	36	23
Eastech Management Company Ltd. 260 Franklin St., Suite 530, Boston, Mass. 02110	Michael H. Shanahan	(617) 439-6130	$34	$26	$26	21	21
Euclid Partners Corp. 50 Rockefeller Plaza, New York, N.Y. 10020	Frederick Wilson	(212) 489-1770	$49	$17	$14	15	11
Fairfield Venture Partners 1275 Summer St., Stamford, Conn. 06905	Eugene E. Pettinelli	(203) 358-0255					
650 Town Center Drive, Suite 810, Costa Mesa, Calif. 92626	Randall R. Lunn	(714) 754-5717	$100	$54	$31	48	24
First Century Partners 1345 Avenue of the Americas, 47th floor, New York, N.Y. 10105	Lisa Roumell	(212) 698-3634	$150	$90	$40	24	10
Fortech International Ltd. 8615 Wild Olive Drive, Potomac, Md. 20854	Dr. L. Wasserman	(202) 898-9795	NA	NA	NA	NA	NA

(Continued)

1988 figures

Company/address	Contact	Telephone	Total paid-in capital ($ millions)	Dollar investment ($ millions) Total	Dollar investment ($ millions) Electronics	Number of companies invested in: Total	Number of companies invested in: Electronics
Grace Ventures Corp. 20300 Stevens Creek Blvd., Suite 330, Cupertino, Calif. 95014	Christian Horn	(408) 725-0774	$70	$47	$27	44	25
Hambrecht & Quist Venture Partners 225 Montgomery St., San Francisco, Calif. 94104		(415) 576-3300	NA	NA	NA	NA	NA
Hambro International Venture Fund 17 East 71st St., New York, N.Y. 10021	Julie Lane	(212) 288-7778	$150	$85	$29	72	19
Idanta Partners 201 Main St., Suite 3200, Fort Worth, Texas 76102	Dev Purkayastha	(817) 338-2020	$80	$80	$40	13	10
Indosuez Ventures 3000 Sand Hill Road, Building 4, Suite 100, Menlo Park, Calif. 94025	David E. Gold	(415) 854-0587	$34	$18	$8	34	15
Intersouth Partners P.O. Box 13546, Research Triangle Park, N.C. 27709	Joseph A. Velk	(919) 544-6473	$25	$6	$3	11	5
Interwest Partners 3000 Sand Hill Road, Building 3, Suite 255, Menlo Park, Calif. 94025	Charles McMinn	(415) 854-8585	$155	$23	NA	NA	NA
Kleiner Perkins Caufield & Byers 2200 Geng Rd., Palo Alto, Calif. 94303		(415) 424-1600	NA	NA	NA	NA	NA
Lambda Funds/Drexel Burnham Lambert 60 Broad St., 7th floor, New York, N.Y. 10004	Alexandra Mahnken	(212) 232-8425	$40	$46	$23	47	19
Lawrence, Tyrrell, Ortale & Smith 515 Madison Ave., New York, N.Y. 10022	Brian T. Horey	(212) 826-9080	$68	$40	$14	30	10
Mayfield Fund 2200 Sand Hill Road, Menlo Park, Calif. 94025	Glenn M. Mueller	(415) 854-5560	$34	$34	$24	36	25
Menlo Ventures 3000 Sand Hill Road, Building 4, Suite 100, Menlo Park, Calif. 94025	H.D. Montgomery	(415) 854-8540	$285	$24	$13	28	20
Merrill Lynch Venture Capital 717 5th Ave., 22nd floor, New York, N.Y. 10022	Kelly M. Pan	(212) 980-0462	$180	$100	$40	60	25
Merrill, Pickard, Anderson & Eyre 2 Palo Alto Square, Suite 425, Palo Alto, Calif. 94306	W. Jeffers Pickard	(415) 856-8880	$180	$150	NA	70	NA
Mohr, Davidow Ventures 3000 Sand Hill Road, Building 1, Suite 240, Menlo Park, Calif. 94025	Michael Sears	(415) 854-7326	$80	$34	$14	36	17
Morgan Holland Ventures One Liberty Square, Boston, Mass. 02109	J.T. McCullen Jr.	(617) 423-1765	$100	$4	$1	4	2
Morgenthaler Ventures 700 National City Bank Building, Cleveland, Ohio 44144	T.A. Laufik	(216) 621-3070	$100	$53	$18	44	8
New Enterprise Associates 1119 St. Paul St., Baltimore, Md. 21202	Nancy Dorman	(301) 244-0115	$400	$282	$225	160	128
Oak Investment Partners 1 Gorham Island, Westport, Conn. 06880	Michele Cassidy	(203) 226-8346	$335	$156	NA	137	100
Pathfinder Venture Capital Funds 7300 Metro Blvd., Suite 585, Minneapolis, Minn. 55435	Brian P. Johnson	(612) 835-1121	$73	$53	$26	50	23
Raytheon Ventures 141 Spring St., Lexington, Mass. 02173	Clyde E. Rettig	(617) 860-2274	$26	$26	$12	11	6
SAS Associates 515 S. Fugueroa St., Los Angeles, Calif. 90071	J.M. Christiansen	(213) 624-4232	NA	NA	NA	NA	NA

(Continued)

1988 figures			Total paid-in capital ($ millions)	Dollar investment ($ millions)		Number of companies invested in:	
Company/address	Contact	Telephone		**Total**	**Electronics**	**Total**	**Electronics**
SRB Management Co. 13455 Noel Road, Suite1670, Dallas, Texas 75240	Jon Bayless	(214) 702-1100	$65	$15	$15	10	10
Sequoia Capital 3000 Sand Hill Road, Building 4, Suite 280, Menlo Park, Calif. 94025	Don Valentine	(415) 854-3927	$300	$200	NA	150	NA
Sevin Rosen Bayless Borovoy 13455 Noel Road, Suite 1670, Dallas, Texas 75240	Dennis Gorman	(214) 702-1100	$150	$100	$100	50	50
Shaw Venture Partners 111 S.W. 5th Ave., Suite 2200, Portland, Ore. 97204	Alan Dishlip	(503) 228-4884	$50	$17	$14	22	17
Sigma Partners 2099 Gateway Place, Suite 310, San Jose, Calif. 95110	Clifford L. Haas	(408) 453-9300					
300 Commercial St., Suite 705, Boston, Mass. 02109	Gardner C. Hendrie	(508) 393-7396	$44	NA	NA	NA	NA
Southern California Ventures 9920 La Cienega Blvd., Suite 510, Inglewood, Calif. 90274	B. Allen Lay	(213) 216-0544	$45	$23	$10	22	5
Summit Partners One Boston Place, Boston, Mass. 02108	Bradley O. Greene	(617) 742-5500					
4675 MacArthur Court, Newport Beach, Calif. 92660	Philip D. Black	(714) 476-2700	$391	$150	$90	54	33
Sutter Hill Ventures 2 Palo Alto Square, Suite 700, Palo Alto, Calif. 94306	Paul M. Wythes	(415) 493-5600	$100	$11	$11	8	8
3i Ventures Corp. 450 Newport Center Drive, Suite 250, Newport Beach, Calif. 92660	Fred Haney Randall Crawford	(714) 720-1421	$200	$145	$100	110	60
99 High St., Boston, Mass. 02110	Allan Ferguson Connor Seabrook	(617) 542-8560					
TA Associates 45 Milk St., Boston, Mass. 02109	Arthur Epker Kenneth T. Schiciano	(617) 338-0800	$226	$61	$47	42	33
435 Tasso St., Palo Alto, Calif. 94301	Michael C. Child	(415) 328-1210					
TVM Techno Venture Management 45 Milk St., Boston, Mass. 02109	Waldemar Jantz	(617) 574-6706	$150	$75	$20	50	15
Trinity Ventures Ltd 20813 Stevens Creek Blvd., Suite 101, Cupertino, Calif. 95014	Noel J. Fenton	(408) 446-9690	$33	$25	$21	22	18
U.S. Venture Partners 2180 Sand Hill Road, Suite 300, Menlo Park, Calif. 94025	Steven M. Krausz	(415) 854-9080	$338	$224	$73	111	44
Venture Capital Fund of New England 160 Federal Street, 23rd floor, Boston, Mass. 02110	Karen Reiche	(617) 439-4646	$35	$7	$2	19	4
Venture Funding Group 49 W. 12th St., Executive Suite, New York, N.Y. 10011	Allan E. Skora	(212) 691-9895	NA	$9	$5	6	3
Warburg, Pincus Ventures 466 Lexington Ave., New York, N.Y. 10017	William H. Janeway	(212) 878-9387	$1,620	$1,400	$106	81	19
Woodside Fund 850 Woodside Drive, Woodside, Calif. 94062	Craig L. Davidson	(415) 368-5545	$30	NA	NA	12	7
Xerox Venture Capital 800 Long Ridge Road, Stamford, Conn. 06904	L.J. Harris	(203) 968-4155	$100	$50	$35	34	NA

(Continued)

U.S. electronics firms venture capitalists are funding

Results of the ELECTRONIC BUSINESS survey of venture capitalists that serve the electronics industry

Advent International: Aspen Technology, Verifone, Halley Systems
Asset Management: Inova Microelectronics, Performance Semiconductor, Sierra Semiconductor
Battery Ventures: Banyan Systems, Network Management, Business Software Technology
Charter Venture Capital: Metricom, Supertelc Computer, InterFox
Chatham Venture: Banyan Systems, Telesoft, Applix

Citicorp Venture Capital: Acer Group, Proteon, Asix Systems
Cornerstone Ventures: Ardent Computers, Digital Microwave, Performance Semiconductor
Crosspoint Venture Partners: Photonics, Whitfield Communications, STAC
Dougery, Jones and Wilder: Excelan, FileNet, Integrated Telecom
Eastech Management: Banyan, Aries Technology, Vicor

Euclid Partners: Xylogics, Banyan Systems, Read-Rite
Fairfield Venture Partners : Ardent Computer, Cadre Technologies, Summagraphics
First Century Partners: Prime Computer, WaferScale Integration, Valid Logic Systems
Grace Ventures: IXYS, Micro Linear, Interlink Electronics
Hambro International Venture Fund: Telematics, Komag, IDE Associates

Indosuez Technology Group: Cisco Systems, Synergy Semiconductor, Sierra Semiconductor
Intersouth Partners: Integrated Silicon Systems, Digital Recorders, Imsatt
Interwest Partners: Radius, Convex Computer, Xilinx
Lawrence, Tyrrell, Ortale & Smith: Sabert Software, ViaSoft, Antrim
Mayfield Fund: Mips Computer Systems, Synergy Semiconductor, Silicon Graphics

Menlo Ventures: Synoptics Communications, Octel Communications, Microcom
Merrill Lynch Venture Capital: Telecom U.S.A., Qume, Everex Systems
Merrill, Pickard, Anderson & Eyre: Cypress Semiconductor, Network Equipment Technologies, Maxim Integrated Products
Mohr, Davidow Ventures: MIPS Computer Systems, Echelon, Insite Peripherals
Morgenthaler Ventures: Verifone, Censtor, Intelledex

New Enterprise Associates : Convex Computer, Dallas Semiconductor, Silicon Graphics
Oak Investment Parnters: Sybase, International Customer Solutions, Vitesse
Pathfinder Venture Capital Funds: Computer Accessories, Digital Systems International, Emerald Systems
Raytheon Ventures: Bipolar Integrated Technology, Sciteq Electronics, Beta Phase
SRB Management: Retix, Optilink, Shared Resource Exchange

Sequoia Capital: Vitesse Semiconductor, Cisco Systems, MasPar
Shaw Venture Partners: Actel, Sequent Computer Systems, Protocol Systems
Sigma Partners: FileNet, Octel Communications, Phoenix Technologies
Summit Partners: Chips & Technologies, Everex Systems, Phoenix Technologies
Sutter Hill Ventures: Weitek, Banyan Systems, Relations Technology

3i Ventures: Netframe Systems, Sierra Semiconductor, Silicon Power
TA Associates: Novellus Systems, PrairieTek, Epoch Systems
TVM Techno Venture Management: Novellus Systems, Cadre Technologies, Digital Research
Trinity Ventures: Vitalink Communications, Conner Peripherals, Alldata
U.S. Venture Partners: Sun Microsystems, Ultron Labs, Analog Design Tools
Woodside Fund: Orion Instruments, Quantitative Technology, Syquest Technology

Multinational workforces on the rise in Japanese firms

As Japan's major electronics companies are shifting more production offshore to counter the high yen, they must cope with 30% to 50% non-Japanese workers

PAULA DOE

Internationalization isn't just a buzzword anymore in Japan. Scrambling to counter the high yen, major Japanese electronics companies have moved some 15% to 30% of their total production offshore in the past several years. That has created a workforce that's 30% to 50% non-Japanese.

Ready or not, Japan's big electronics exporters have become multinational companies. Now the task is to figure out how to make it work.

Currently, half or more of the workers at major Japanese electronics companies — including Alps Electric Company Ltd., the Sanyo Electric Company Ltd. group and Sharp Corp. — are not Japanese. And Canon Inc. expects two out of every three of its employees will be outside of Japan within 10 years.

One basic first step toward becoming a global company is to reorganize the corporate structure to give local operations more autonomy. In a rush of enthusiasm for regional control, Matsushita Electric Industrial Company Ltd., Mitsubishi Electric Corp., NEC Corp., Sanyo, and Toshiba Corp. have all reorganized their foreign operations in recent months.

Most Japanese overseas operations traditionally have been sales or manufacturing branches of particular product divisions: the television group set up television factories abroad; the semiconductor group assembled integrated circuits overseas. Executives in the product group in Japan called the shots, working through plant managers and sales managers sent from Japan. Units of different product groups often had little to do with one another. But the trend this year is toward establishing regional corporate headquarters in North America, Asia and Europe to take charge of all activities in their respective areas.

Mitsubishi's latest tactics, for example, call for building autonomous companies abroad. "Our overall view of world trade is that, quite against everyone's expectations, there will be a U.S.-Canada bloc, a European bloc, and an Asian bloc," explains Takeshi Sakurai, president of Mitsubishi Electric America Inc., in Washington, D.C. "These blocs are taking shape because of protectionism, so we have to create an organization to deal with that. There will be fewer transactions across the ocean. We will build autonomous R&D and manufacturing in each bloc. . . . It's a waste of time and money, but we believe it is going to happen."

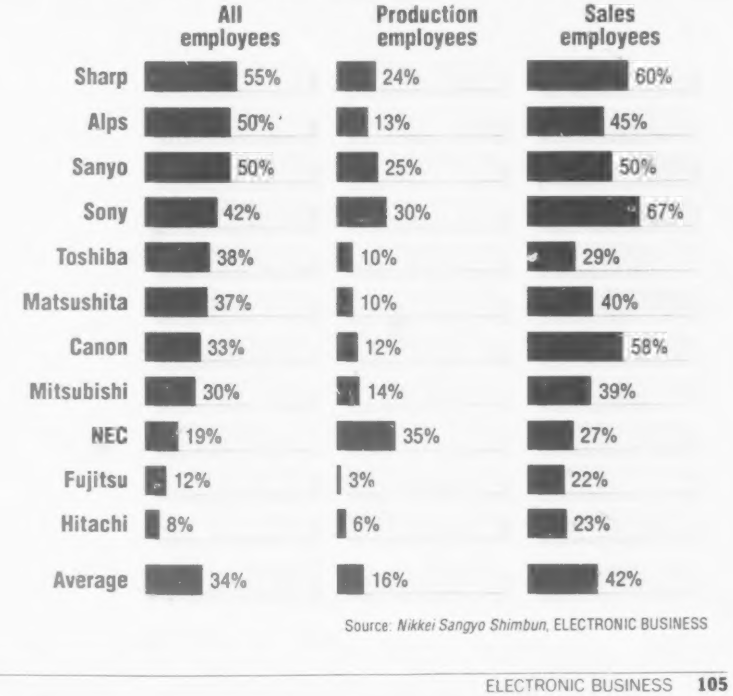
New U.S. headquarters

Toshiba, Matsushita, and Sanyo have also established new U.S. corporate headquarters units in recent months, to oversee all North American operations, and are working on the same arrangement in Europe and Asia. The regional headquarters will supply corporate staff for all units in law, finance, advertising, and the like.

Toshiba has also combined its scat-

Japan's growing foreign workforce

Non-Japanese employees as a percentage of total workforce



Source: *Nikkei Sangyo Shimbun*, ELECTRONIC BUSINESS tered U.S. sales and manufacturing operations by product line, so each of five U.S. subsidiaries will now control both sales and manufacturing in its product area. All will report to a new U.S. corporate headquarters instead of their product groups in Japan, while the U.S. headquarters will report to a new high-level international division in Japan.

"It gives us a lot more independence," says a spokeswoman for Toshiba's U.S. consumer products business.

NEC is moving away from central control in a slightly different way, with a new tactic called "mesh globalization." Instead of trying to produce goods where they will be consumed, the company intends to locate production in the optimal place. This means semiconductors made in the United States may be assembled into products in Asia for sale in Europe. So managers in all these locales will have to deal more directly with one another, without going through Tokyo all the time, and reportedly will have more authority.

All this should be good news for local management. Non-Japanese nationals were automatically relegated to a relatively low corporate level when foreign operations were simply a minor arm of a Japanese product group. Even the Japanese executives in charge overseas were fairly low in the corporate hierarchy. But senior positions in a U.S. headquarters are another matter. If regional units really are given significant autonomy, it is easier to imagine non-Japanese eventually taking larger roles in local management.

Sony, long among the most internationally oriented of the major Japanese electronics companies, has had a similar regional structure for some time. Sony Corporation of America's U.S. president is Neil Vander Dussen. Most of Sony's European units also have non-Japanese presidents.

"I think we may see a U.S. president very soon," Mitsubishi Electric's Sakurai says.

Indeed, developing the personnel they will now need to function globally is a prime concern of these newly multinational Japanese companies. The first step is an intensified effort to make their Japanese employees more international in outlook.

Canon presents a leading example of the impressive scope of some of these stepped-up personnel development efforts. Canon, like Sony, already has a reputation as one of the more international of the Japanese electronics companies. Before the high yen, the company used to get 75% or so of its revenue from exports. Now Canon's tactic is to manufacture each product in its largest market, and it expects to be doing 60% of all its production outside of Japan in 10 years.

Teaching everyone English

Canon already teaches English to its university graduates, and has an intensive, 100-hour course in international business and foreign cultures for managers being sent overseas. But now the company has decided that if it is to become a truly international company, it must extend such training to all of its employees.

The harder issue, just now being tackled by companies, is how to turn foreign managers into real Japanese company men

So now Canon has begun teaching English to its blue-collar workers so they will be able to work more closely with workers overseas, such as when they help set up the company's U.S. electronic typewriter plant this summer. Canon also plans to start putting employees not going overseas through its international training program, and it plans to greatly increase the number of Japanese employees it sends abroad, and to keep them abroad longer. Those on executive career paths will now be expected to spend 15 years overseas. In what may be the biggest step of all toward true internationalization, Canon is now letting its Australian subsidiary take charge of training the Japanese posted there in Australian business and culture.

Similarly, other companies are trying to create a workforce that can function internationally. Alps, which has only some 12,000 employees in Japan, has never considered itself a major multinational. But with its recent rapid expansion of overseas production, the company finds itself this year with more non-Japanese than Japanese employees. So it is making English the official company language, and looking hard at doing all its design documentation, technical manuals, and production manuals in English. Alps also sends 100 Japanese employees a year through its training in foreign language, foreign culture, and Japanese culture, and selects 30 to 40 of those to send overseas.

The harder issue, just now being tackled by some of the most internationally experienced companies, is how to turn foreign managers into real Japanese company men. Japanese executives are finally beginning to discuss seriously not just whether but how to integrate foreigners into the Japanese corporate leadership. This is a big step in a country where even Japanese who attend foreign universities are still somewhat suspect. One major Japanese electronics company recently made headlines for putting a foreigner in charge of a research group — although the so-called foreigner was born in Japan and graduated from the University of Tokyo; his father was not Japanese.

Many companies are sending foreign staff to Japan for short periods for training, regular corporate meetings and management seminars. Others are trying more extensive assignments: Mitsubishi Electric has sent about 100 young engineers from the United States to its semiconductor plants in Japan for nine months to a year.

Sony and NEC are at the forefront of actually assigning non-Japanese to regular jobs in Japan, in a radical attempt to develop an elite corps of foreigners with a clear understanding of the parent company. More than 75 foreigners work at Sony headquarters in Japan, and more are at the plants. An American heads Sony Video Software Co. A West German is the deputy manager of Sony's television group. Besides the 180 managers from 25 countries who have been through NEC's three-week management seminar, eight have been transferred to Japan on regular two-year assignments. The company plans to post five or six more on regular job assignments to Japan this year. ☐

VGA and beyond: Tough choices challenge vendors

Despite being consumed by issues of maturity — competition, distribution, pricing — vendors nonetheless must look ahead: Do you go with IBM or TI?

BY RICK WHITING

Vendors of Video Graphics Array (VGA) products for the IBM personal computer and compatible marketplace are facing some critical decisions as the VGA market rapidly matures and the battle begins for a successor graphics standard.

Manufacturers of VGA microprocessors and graphics boards are experiencing increased competition, falling prices and changes in distribution channels. But even as they struggle with an existing market that is driven by increased demand for graphics capabilities on PCs, vendors are already thinking about the future, where IBM and Texas Instruments Inc. are competing to control the next generation of products.

VGA, a VLSI graphics controller, was unveiled by IBM in April 1987 along with the PS/2 line of personal computers. Intended as a successor to the earlier Enhanced Graphics Adaptor (EGA) specification, VGA was quickly accepted by third-party vendors who rushed to bring VGA products to market.

Annual sales of EGA products peaked in 1987 at $213 million, although sales remain steady, according to International Data Corp., a market research firm. EGA is the graphics standard associated with Intel Corp.'s 80286 microprocessor, the chip used in the majority of PCs being sold today.

VGA is the graphics standard associated with 80386-based PCs. IBM and Compaq Computer Corp., whose sales efforts are focused on 80386-based PCs, are emphasizing VGA in their marketing strategies. Sales of VGA add-in products surpassed sales of EGA products in this year's first quarter, and IDC expects VGA dollar volume sales to peak in 1990 at $254 million. (IBM sells a minuscule number of add-in VGA products and components integrated into PS/2 computers are not counted in the IDC figure.)

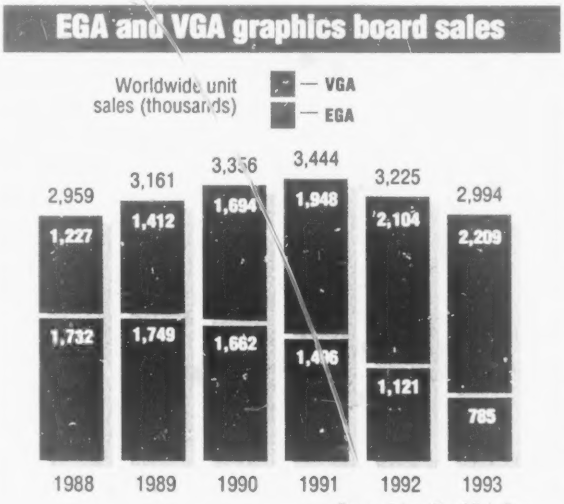
Some vendors believe that VGA will offer growth potential beyond that. "VGA, as a standard, is probably several years away from peaking," says Robert V. Dickinson, vice president and general manager of the computer graphics unit at Western Digital Imaging in Mountain View, Calif., a business unit of Western Digital Corp. Western Digital claims that apart from IBM, it holds over 50% of the market for VGA products.

But others predict that the market could top out earlier. "I think that the VGA market has matured significantly faster than the EGA market did," says Robert Butchko, president of Renaissance GRX Inc., a Bellevue, Washington-based vendor of graphics application-specific ICs, boards and software.

VGA is being assured a longer life span by third-party vendors that have begun marketing "extended mode" products, boards and chips offering more power and higher resolution. Although 640 pixel by 480 pixel resolution is the minimum standard for PCs based on Intel's 80X86 microprocessors, vendors such as Headland Technology Inc., Fremont, Calif., are now offering VGA boards with resolution as high as 1024 pixels by 768 pixels.

The increased demand for graphics capabilities on PCs is being fueled by increasingly graphics-oriented software, such as Microsoft Corp.'s Presentation Manager user interface. "The need for color, the need for more significant graphics of all kinds, is just growing by leaps and bounds," says Butchko.

And with a huge installed base of PCs with aging graphics technology, industry watchers believe that upgrades offer a potentially lucrative market. But vendors are split on whether the majority of PC owners will migrate to EGA or VGA products. "Corporate purchasers are much better off buying VGA rather than EGA for insuring [compliance with]



Source: International Data Corp.

VGA is being assured a longer life span by third-party vendors that have begun marketing "extended mode" products

future standards," says Richard Brown, marketing and sales managing director at Trident Microsystems Inc., a Sunnyvale, Calif., graphics chip manufacturer.

Nevertheless, competition remains keen among vendors of VGA chips and particularly among graphics board manufacturers. "It's a crowded market," says Greg Reznick, Headland's systems marketing vice president. But industry watchers believe the number of vendors in the market has stabilized and is neither growing nor shrinking.

Despite its growth, the VGA market is not without its pitfalls. IDC projects that pricing for VGA boards will have dropped 60% between 1988 and 1993. Vendors say that prices have been falling — and profit margins eroding — in the last eight to 10 months. "There is a tremendous price erosion in the market today," says Renaissance's Butchko.

But Reznick and others attribute the sharp drop in prices to the decreasing price of DRAMs. Last year manufacturers had to boost prices because of the DRAM shortage and some vendors of EGA products were forced out of the market.

As the technology improves and multiple chipsets are reduced to one or two chips, more and more PC manufacturers are putting graphics chips directly onto the CPU board. IBM now puts VGA chips onto the CPU of its more powerful PS/2 systems and offers VGA add-in boards for low-end PS/2s and older PCs.

That means that while the OEM channel will remain strong for VGA chips, vendors of VGA boards may be forced to concentrate their sales efforts on retail channels. But Butchko says it will be about a year before the majority of VGA chips are used on CPUs, and that OEM demand for graphics boards will remain strong.

"Players in the marketplace with their own VGA chips and own low-end products are the ones that will survive," predicts Butchko. "I think you need to create your own ASICs to keep costs down to keep your margins in a real backsliding marketplace."

"Control your own silicon, because that is where the value in this market lies," agrees Western Digital's Dickinson.

Marketers of VGA products should concentrate on differentiating their wares by offering improved software, rather than simply selling products with the highest performance at the lowest price, advises Alan Lofthus, logic products director of NCR Corp.'s microelectronics division.

Dickinson also believes that the graphics arena is no longer an entrepreneurial market. He says larger companies with the resources to develop broad product lines are the ones that will succeed. Western Digital also markets graphics boards under the Paradise brand name.

A sure sign that the VGA market is maturing is the formation last April of the Video Electronics Standards Association (VESA), a consortium of graphics chip, board, and

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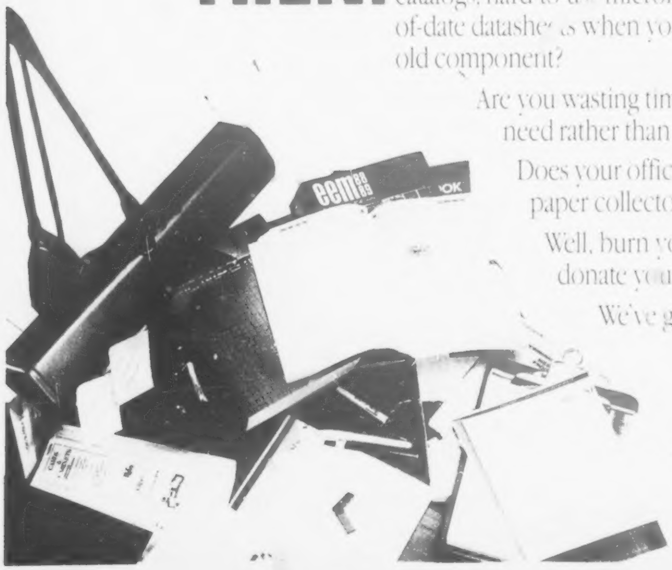

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monitor manufacturers, whose goal is to establish personal computer graphics standards.

VESA has already adopted a standard software interface for 800 pixel by 600 pixel resolution in the extended VGA mode. "It's a unified approach to a de facto standard," says Larry Liang, marketing and sales senior vice president at Genoa Systems Corp., a San Jose-based marketer of graphics hardware and software.

IBM vs. Texas Instruments

Even as vendors wrestle with changes in the existing market, a struggle is already shaping up between TI and IBM over the future of PC graphics. IBM now offers add-in boards with its next-generation 8514/A graphics microprocessor for 1024 pixel by 768 pixel resolution, while TI is promoting its 34010 chip as an alternative.

Backers of the 8514/A argue that because the microprocessor is specifically designed as a graphics chip, it offers better performance than TI's competing product. Those endorsing the 34010 maintain that the chip's programmability makes it more flexible. Both sides argue that their product is more cost-effective.

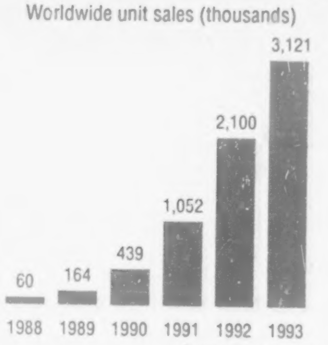
"The 8514/A and TI chip is a real battle," says Butchko. Renaissance plans to debut a graphics controller this fall based on the 34010 to compete with the 8514/A and the expected wave of IBM clones.

Other vendors are throwing in their lot with the IBM graphics specification. "We think the IBM product is a clearly superior solution for the personal computer market," says Dickinson. Last month Western Digital unveiled what it claims is the first full register-level 8514/A-compatible chipset offering 1024 pixel by 768 pixel resolution, and an extended mode with 1280 pixel by 1024 pixel resolution.

Analysts believe that while the TI chip will make some gains in high-performance niche applications, most are betting that the 8514/A will gain wide acceptance. According to a report from market researcher Dataquest Inc., market share will hinge on IBM compatibility — rather than performance — and therefore it expects the 8514/A to win out.

IBM is projected to ship 150,000 8514/A-based products this year and is expected to begin adding the chip to the CPU board of high-end PS/2 models, Dataquest says. ☐

8514/A and compatible graphics board sales



Source: Dataquest Inc.

IBM compatibility, not performance, will make 8514/A-based products successful

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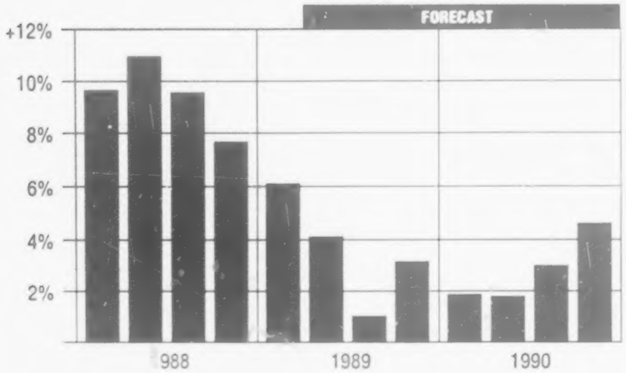
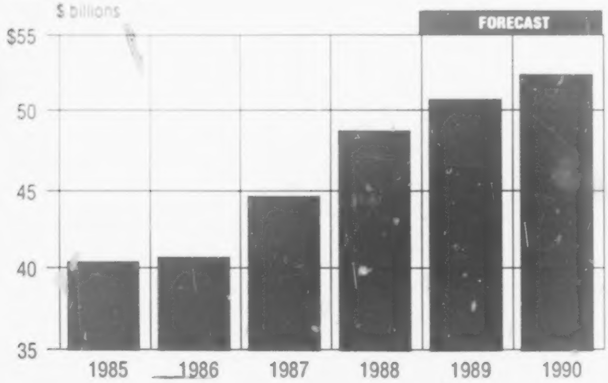
Scientific & engineering instruments shipments

Percentage change from year-ago

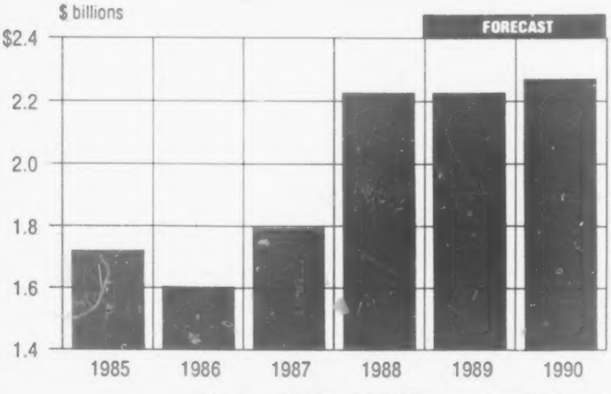


Annual totals



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Worldwide ATE sales



Data source: ELECTRONIC BUSINESS; Forecast: Cahners Economics

Growth rates slow as economy weakens

From March to April, new orders for scientific and engineering instruments jumped 4.5% and shipments edged up 1.6%. Even with the one-month rise, April new orders of $4.2 billion gained just 1.5% over last April's figure, while the total of $4.1 billion in shipments actually fell just over 1% compared with April 1988.

The fact that this industry reached its business cycle peak and growth rates are slowing down has been evident for some time. Since the second quarter of 1988, the quarterly growth rate in shipments has been shrinking. In that quarter, shipments of $12.2 billion climbed 11% from the year-earlier period. The growth rate dwindled to 10% in the third quarter, 8% in the fourth quarter, and 6% in the first quarter of this year.

Cahners Economics expects this steady decline to continue through most of this year before growth rates flatten and then start heading up again in late 1990 or early 1991. Although growth is expected to decelerate, it is not forecast to be negative, so U.S. factory shipments will continue to increase. Shipments will expand by almost 4% to an annual total of $50.8 billion by the end of this year, and inch up another 3% in 1990. The preliminary outlook for 1991 is for strong gains of close to 10% in U.S. shipments as business investment picks up after a year-and-a-half lull.

The current downturn in the instruments industry will not be as jarring as the previous slump. Inventory remains under tighter control now than in the past, and backlogs, at $13.5 billion, stand 5% above a year ago. Even with the recent comeback in the dollar, foreign sales will help bolster U.S. shipments.

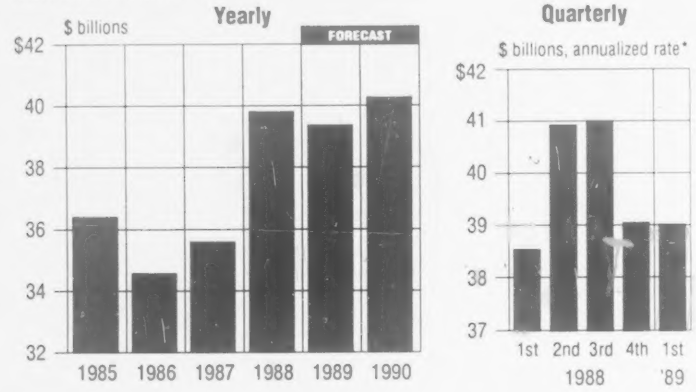
As expected, growth rates in the ATE industry turned the corner. The ELECTRONIC BUSINESS ATE sales index came in at 752.7 (1976 Q1 = 100) in the first quarter of 1989 — a 3% drop from the first quarter of last year. Growth is expected to drop off quickly so that by the end of this year ATE sales will have grown just 0.2%. That is a downward revision from the original 4% forecast as the result of a weaker than expected first-quarter performance. In dollar terms, worldwide ATE sales will amount to $2.22 billion in 1989 and $2.26 billion in 1990.

MADELINE FRANCHI

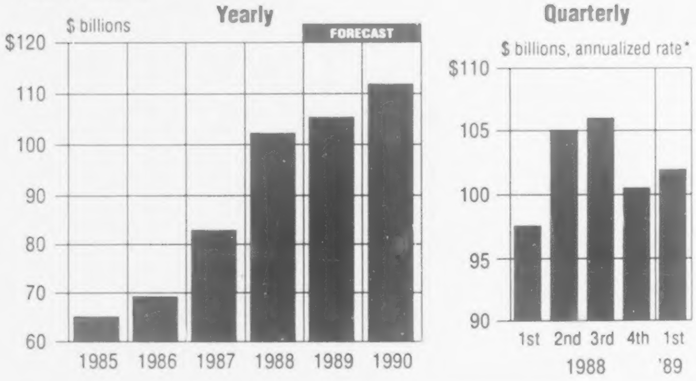
This topic is scheduled to appear again in the October 15th issue.

Business purchases of computers & office equipment

Current dollars



1982 dollars



* Seasonally adjusted

Data source: U.S. Commerce Department; Forecast: Cahners Economics

Computer buying expected to decline

In the first quarter of this year, U.S. businesses spent an annualized $39.1 billion for computers and office equipment — up 1.2% from the level in the first three months of last year. Although still above the level of a year ago, the spending pace for computers and office equipment has indeed slowed. In the second quarter of 1988, business expenditures for computer systems swelled to an annualized $41.0 billion — 18.2% above the second quarter of 1987. Since then, the year-to-year quarterly growth rate has steadily shrunk to the most recent 1.2%.

This pullback suggests both buyer uncertainty about the economy and computer standards and the fact that many businesses already upgraded their systems and won't be buying as much this year.

On a current-dollar basis, Cahners Economics forecasts about a 1.0% decline in U.S. business purchases of computers and office equipment by the end of this year. This contraction will be mild and short compared with the 1985-1986 recession.

MADELINE FRANCHI

This topic is scheduled to appear again in the October 15th issue.

Computer market database

Latest quarter: 1st quarter 1989	Latest quarter	Previous quarter	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, qtr. average)	336.33	322.03	+4.44%	305.33	+10.15%	324.37	-3.56%
Shipments (SA, $ millions, qtr. total)	$16,840	$16,839	+0.01%	$16,225	+3.79%	$16,650	-1.13%
New orders (SA, $ millions, qtr. total)	$16,570	$16,590	-0.12%	$16,003	+3.54%	$16,348	-1.34%
Unfilled orders (SA, $ millions, qtr. total)	$13,201	$13,471	-2.00%	$13,729	-3.85%	$12,668	-4.03%
Inventory-to-shipment ratio (SA, end of qtr.)	2.08	2.13	—	2.02	—	2.18	—
All employees (thousands, end of qtr.)	474.8	479.4	-0.96%	468.7	+1.30%	470.6	-0.89%
Production workers (thousands, end of qtr.)	155.2	156.3	-0.70%	157.5	-1.46%	150.5	-3.05%
Business purchases (current $ billions)	$13.02	$13.03	-0.08%	$12.86	+1.24%	$13.24	+1.69%
Business purchases (1982 $ billions)	$34.27	$33.49	+2.33%	$32.48	+5.51%	$35.78	+4.41%

SA = seasonally adjusted; all other data is not seasonally adjusted

Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

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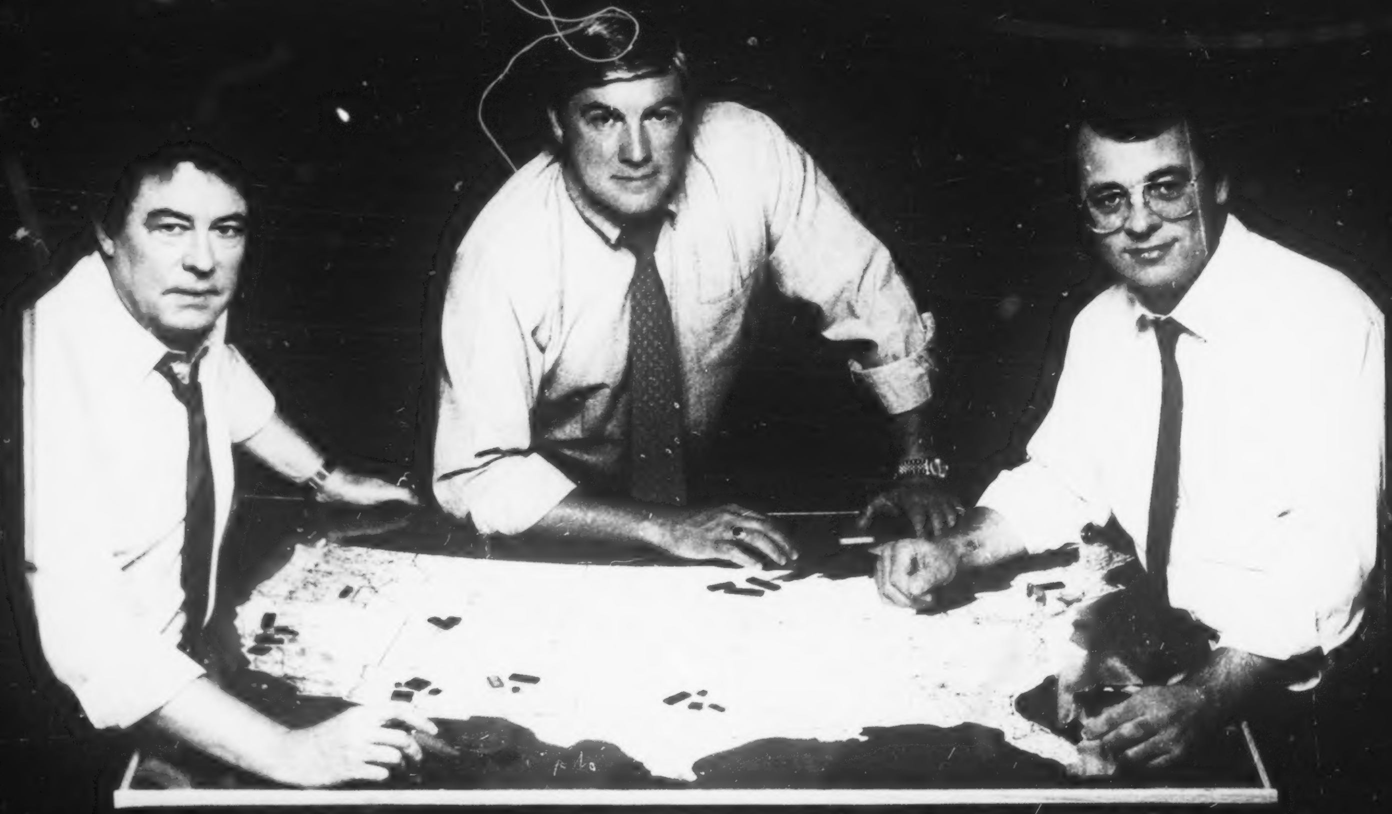
SIX DOLLARS

A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

AUGUST 7, 1989



From left to right: SGS-Thomson's Daniel Queyssac; Philips/Signetics' James Dykes; Siemens' Wilfried Backes

IT'S NOW OR NEVER

European chip makers plot last-ditch assault on U.S.

PAGE 24

The top 100 U.S. R&D spenders PAGE 50

George Gilder: The New American Challenge PAGE 36

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 15, NO. 16 AUGUST 7, 1989

PAGE 24 SGS-Thomson's Daniel Queyssac, Philips/Signetics' James Dykes and Siemens' Wilfried Backes: Seeking to increase semiconductor market share in the United States

COVER STORY/EUROPE BUSINESS

24 It's now or never for Europe's chip makers

Enough is enough. That's the sentiment of European semiconductor manufacturers, who despite past failures, aim to be global leaders rather than followers. But in order to take on the world, the Europeans admit they first must take on the United States.

BUSINESS TRENDS

17 Modem chipset makers count on booming market

Modem chipset makers expect the market for their product to expand rapidly now that VLSI technology has brought single chips and lowered prices accordingly.

EUROPE BUSINESS

24 It's now or never for Europe's chip makers

Despite a more focused U.S. stance the deck might be stacked. The Europeans still must live down their reputations as "marketing-adverse" companies, perennially afflicted by "techno-lag." But if monetary investment is a measure of commitment, then the Europeans are on the right course: The big three — SGS-Thomson, Philips and Siemens — have spent upward of $1 billion within the past five years to try to make it big in America.

27 **Takeover mania leaves Plessey dangling**

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30 **Siemens vs. NEC: Gauging U.S. success**

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36 The New American Challenge

The first of two excerpts from George Gilder's upcoming book on the semiconductor industry, *Microcosm*. In this part, the best-selling author explains how world wealth has shifted from the form of physical resources to the power of the mind — ideas and technologies. Epitomizing this rise in the source of wealth, Gilder argues, is the microchip.

46 "Do or die" time confronts Schlumberger

Behind the leadership of test veteran Irwin Pfister, this former automatic test equipment titan aims to restore customer confidence — and slipping market share. To do so, Pfister has embarked on a focused approach that seeks to improve the quality of Schlumberger products and service while still bringing new product to the market.

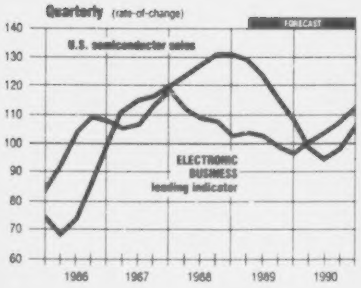
MANAGING RESOURCES

50 Top 100 R&D spenders increase investment by 15.7%

There were no great surprises on the ELECTRONIC BUSINESS 1988 list of the top 100 research and development spenders in the electronics industry. Total R&D spending rose to $18.2 billion, with a growth rate that mirrors the rise in sales for the same companies.

52 **Top 100 U.S. R&D spenders**

Cover photograph: Christopher Springmann



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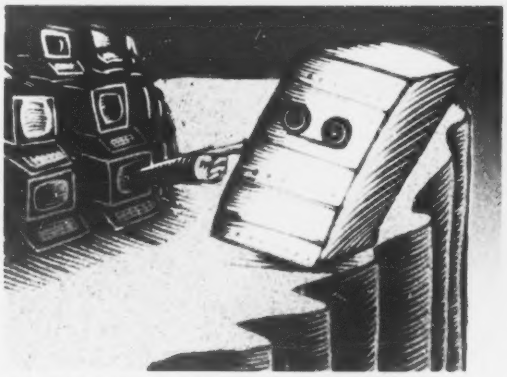

PAGE 36 George Gilder's "The New American Challenge," an excerpt from *Microcosm*

PAGE 17 Silicon Systems' Rick Goerner: "New modem applications will proliferate" as the costs for modem chipsets come down

61 Sign of the times: Even Cray scales back R&D

It is a sign of the times when Cray Research, the supercomputer pioneer, decides that it, too, has to scale back its R&D ambitions. Slowing revenue growth and rising R&D costs has forced the supercomputer pioneer to consolidate its research efforts, ending its obligation to the risky Cray-3.

ASIA/PACIFIC BUSINESS

69 Korean labor unrest stymies U.S. electronics firms

The days of docile and cheap Korean labor are rapidly becoming a fading memory as Korean workers are demanding higher wages and union representation. Caught in the crossfire of this labor turbulence are subsidiaries of American companies — including those of U.S. electronics firms.

MARKET PERSPECTIVES

76 Minisuper shakeout survivors foresee a revived market

Although the crowded, highly competitive minisupercomputer market has been in the doldrums — falling far short of its advance billings of only a couple of years ago — a strong revival is expected. The wild card in the market is Digital Equipment Corp., as potential buyers of minisupers have delayed purchases until they see what DEC has to offer.

BUSINESS BAROMETER

86 Components

A mixed performance in delivery times of electronic components probably signals neither great growth nor a recession, but simply a flat period ahead.

87 Leading indicator

The ELECTRONIC BUSINESS indicator clearly says the 1989 downturn will be much milder than the last electronics industry recession.

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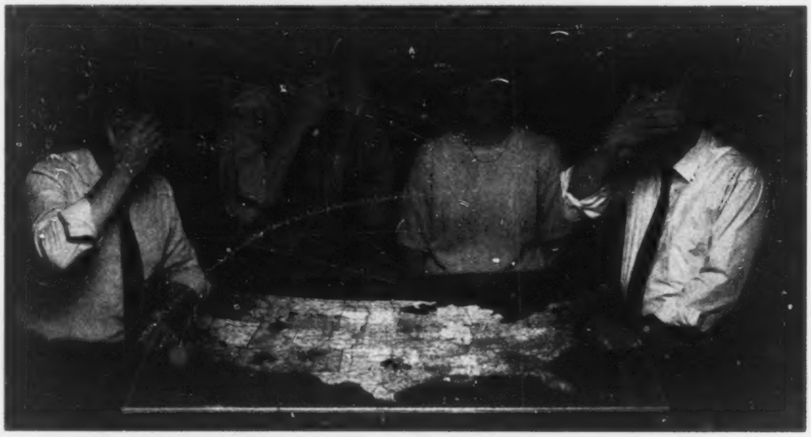
It's now or never



Senior editor Valerie Rice and Queyssac, Dykes and Backes

Chris Springmann

There's a keen sense of desperation these days among Europe's biggest semiconductor manufacturers — that if they don't dramatically increase their static 7% share of the U.S. market the Europeans can dismiss all hopes of being serious worldwide players. Our San Jose-based bureau chief Valerie Rice, who authors our cover story, says the Europeans do realize time is running out.

Valerie spent a month in Europe interviewing executives of Europe's big three — SGS-Thomson, Siemens and Philips. Her travels took her to Paris, London, Milan, Amsterdam and Munich. The European chip makers, long perceived in the U.S. as lagging in technology and marketing, are eager to be taken seriously.

In the photograph that accompanies this column, Valerie is seen during a relaxed moment with three executives of the U.S. operations of SGS-Thomson, Siemens and Philips. The photo, by free-lance photographer Chris Springmann, is the exact set-up as the cover and was shot in San Jose. The mood created is that of a military strategic planning room.

As the cover picture suggests, the European chip makers are plotting their last-ditch assault on the U.S. market. Whether it will work or not is a leading question. Competitors, customers and market experts all have their doubts. As Valerie points out, if Europeans don't get up to speed in the United States there may not be a tomorrow.

Gilder's Microcosm

The central event in the 20th century has been the overthrow of matter, where world wealth has shifted from the form of physical resources to the power of the mind. That view is put forth by best-selling author George Gilder in his upcoming book, *Microcosm: The Quantum Revolution in Economics and Technology*, which explores the meaning and future of modern technology. We think it will be an important book and are excerpting two chapters, beginning with this issue.

MARVIN GREENE, section editor

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BPA ABP

It's now or never for Europe's biggest chip makers

In a last-ditch effort to be global semiconductor players, the Europeans are facing their moment of truth. Can they plot a U.S. strategy that's aggressive enough — or must they forever hold their peace?

BY VALERIE RICE

Enough is enough for European semiconductor manufacturers, also-rans even in their own home markets last year and perennial players in a global game of follow-the-leader. In what many observers see as a last-ditch effort, the Europeans are pinning their hopes for a brighter future on making it big in the U.S. market.

The three European principals — SGS-Thomson Microelectronics, N.V. Philips GL and Siemens AG — have been present in the United States for more than 10 years, but their semiconductor successes have gone largely unnoticed by competitors and customers alike. Now, though, as the U.S. market is being carved into increasingly small chunks by Japanese, Korean and other Pacific Rim companies, the Europeans must make their move — or forever give up an opportunity at the world's second largest semiconductor market.

The Europeans are plotting to take on the world via a renewed assault on U.S. semiconductor business. Quietly, over the past 18 months, European companies have been putting structures into place — second-sourcing arrangements, alliances, larger salesforces and a new attitude — that will support a sustained and vigorous attack on the market.

"We have a couple of years grace time now," says Philips Components' Signetics operation president James Dykes of his company's status. "But if we don't make a big splash soon, we will hurt ourselves in the long run."

But this aggressive stance is something new for the Europeans, who nonetheless may be playing against a stacked deck. European chip makers are typically slow to react to the market, top heavy, and, some market observers say, two years or more behind the United States in technology and marketing. Yet SGS-Thomson, Philips and Siemens have spent upward of $1 billion within the past five years to acquire the technology and even the chutzpah necessary to make it big in the United States.

"To be a global player, truly global, you have to be in the U.S.," stresses Siemens' Christoph Horstman, the Munich, West Germany, company's components division executive director. "We have been damned late getting into the U.S. I only hope it's not too late."

Trailing the pack

After at least 10 years in the U.S., and in some cases more than 15 years, the Europeans do not have much to show for their presence. Data from San Jose-based

SGS-Thomson's Daniel Queyssac, Philips/Signetics' James Dykes and Siemens' Wilfried Backes, left to right, all have designs on capturing more U.S. market share

Christopher Springmann

market researcher Dataquest Inc. indicates that European semiconductor market share in the U.S. has remained a static 7% of the total market over the past two years. But the Europeans are being outpaced by the upstart Koreans, whose 3% market share last year masks a growth rate much higher than that of the Europeans, says Dataquest's North American IC director Victor de Dios.

The Europeans have not racked up a lot of technology "firsts" in that time, either. Although global leaders in power ICs, optoelectronics, discretes and analog, the Europeans are not at the forefront of any of the high-growth, cutting edge technologies, according to an informal ELECTRONIC BUSINESS survey of market analysts across the United States.

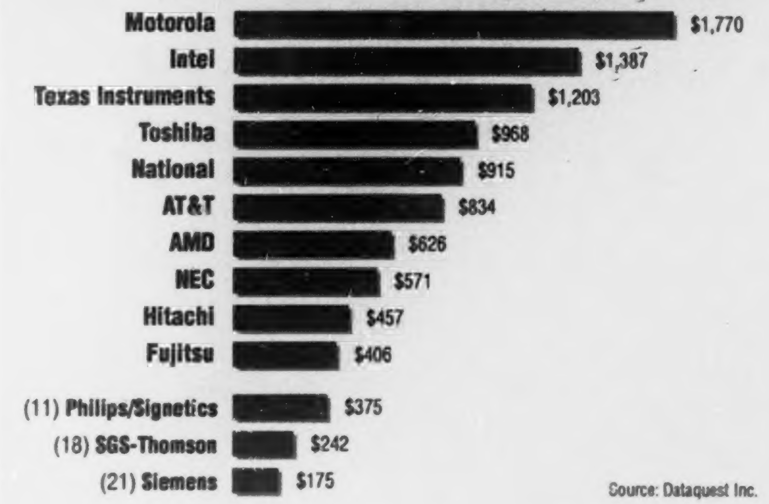
Signetics Corp., of Sunnyvale, Calif., and its parent Philips are actually losing worldwide — and particularly U.S. — market share. Last year they dropped to a new low — No. 11 worldwide — from a high of No. 3 three years ago, according to Dataquest. In fact, the U.S. market is the only part of the world where Philips actually experienced negative market growth last year; the firm's U.S. revenue declined by 4% in 1988 over 1987. And Signetics' revenue picture is not a pretty one. Last year's revenue of $562 million is more than $150 million short of the company's peak of $720 million in 1984.

"The position of Signetics in the market today can be, has to be, improved," declares Heinz Hagmeister, Philips Components IC business unit managing director, based in Eindhoven, The Netherlands.

"No. 20 in the world is not exactly a leadership posi-

Leaders in the U.S. semiconductor market

1988 North American semiconductor revenue ($ millions)



Source: Dataquest Inc.

tion," acknowledges Siemens' Horstman, of his company's rank. And he is right. Siemens' U.S. integrated circuit sales, after more than 10 years of trying to penetrate this market, are not yet $100 million, according to analysts' estimates. The company acknowledges that its U.S. market share is still less than 1%. Siemens did, however, show a 17% U.S. growth in 1988 over 1987, according to Dataquest, but that percentage still leaves it underperforming the U.S. market as a whole; the U.S. market grew at 25% last year. Siemens' total IC revenue worldwide last year was $440 million.

SGS-Thomson actually gained U.S. share last year — it now has 3%, according to the company — giving it the distinction of being the only European company to do so. The Franco-Italian company, with European headquarters in Agrate, Italy, and Paris, also recorded a 40% sales increase in 1988 over 1987, according to Dataquest. But SGS-Thomson has to live with the fruits of its lost opportunity in DRAMs. The Thomson-Mostek merger gave the company both patents and a DRAM-capable fab, but reluctance on management's part has put it in the position of having to now "creep back into the DRAM market," says the company's Phoenix, Arizona-based U.S. president Daniel Queyssac.

America or bust

Based on U.S. market numbers, it is obvious that European companies had to change their ways. Historically weak in marketing, sales presence and technology, the Europeans, their new structures now in place, are giving it their all. For some firms, this new emphasis has been easier than for others.

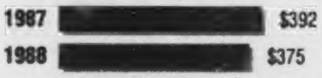
"The biggest increase in our sales today is coming from America," says SGS-Thomson's corporate vice president for marketing Philippe Geyres. But Geyres, based in Paris, says SGS-Thomson is not satisfied with its 3% share of the U.S. market, particularly if it is going to meet its goal to be a top 10 semiconductor player worldwide. "We want to have 5% of the U.S. market," he declares. "That is the minimum we need to be a world class player."

To get there, SGS-Thomson, which employs an 1,800-person staff in the United States, has asked its stockholders to accept minimal profit over the next few years, Geyres says. That

Highlights of top European companies' U.S. semiconductor sales

N.V. Philips*

Total U.S. semiconductor sales ($ millions)



Leading products: 1988 U.S. sales ($ millions)

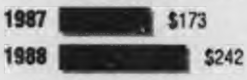
Bipolar standard logic: $124
Analog: $68
Microcomponents: $39
Bipolar ASICs: $29
MOS memories: $16
MOS ASICs: $4

* Includes Signetics Corp.

Notes: MOS memories figure represents primarily nonvolatile memories. Philips/Signetics had no SRAM revenue from the U.S. in 1988, and only $2 million from SRAMs worldwide.

SGS-Thomson

Total U.S. semiconductor sales ($ millions)



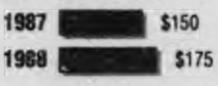
Leading products: 1988 U.S. sales ($ millions)

Analog: $59
Nonvolatile memories: $35
Microcomponents: $30
SRAMs: $24
MOS ASICs: $20

Notes: The SGS-Thomson figure for microcomponents represents almost $15 million in microcontrollers alone: These figures also do not include recent acquisition Inmos Ltd., which would add another $62 million to SGS-Thomson's U.S. sales in 1988.

Siemens AG

Total U.S. semiconductor sales ($ millions)



Leading products: 1988 U.S. sales ($ millions)

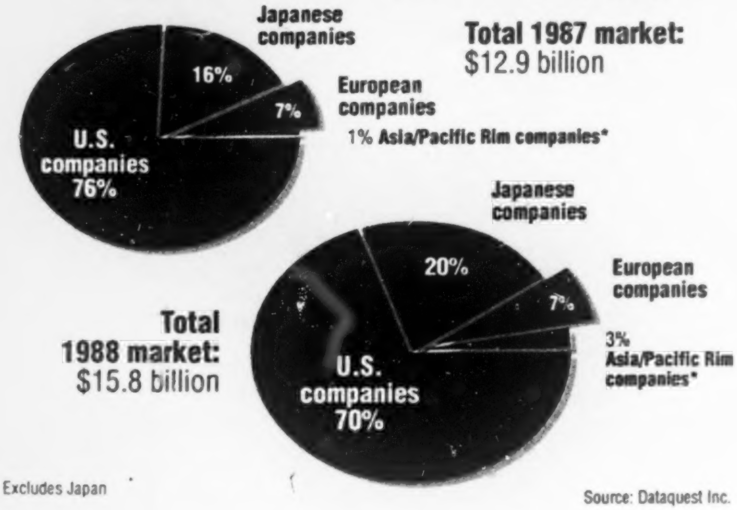
Discretes: $54
ASICs: $10
Microprocessors: $10
DRAMs: $9
Bipolar: $3

Notes: The majority of Siemens' sales in the U.S. were in MOS, representing $68 million of the total figure.

Source: Dataquest UK Ltd.

Foreigners' shares of U.S. semiconductor market

Share of the North American semiconductor market by company origin



* Excludes Japan

Source: Dataquest Inc.

way, cash will be available for expansion in the United States and Japan.

That expansion has already begun. Capacity at the company's Carrollton, Texas, fab facility has more than doubled over the past year, and the U.S. salesforce has been beefed up. Additionally, more U.S. design centers are being added to support SGS-Thomson's latest acquisition, the Transputer from Britain's Inmos Ltd., again with an eye toward increasing profits. Inmos is once again ramping up its SRAM business to work in conjunction with SGS-Thomson, and Geyres says he has high hopes for their prospects in SRAMs.

But DRAMs are a different story. U.S. president Queyssac says the company must be in the DRAM business, but anticipates no headlong rush. Rather, SGS-Thomson will go slowly, and produce products as it can support them. At the very least, however, SGS-Thomson will now be able to add Inmos' U.S. revenue to its own, bringing the company closer to that critical mass of $1 billion that Geyres, Queyssac, and chairman Pasquale Pistorio are so adamant about.

While SGS-Thomson is empire building, Philips/Signetics is in a salvage mode. Philips and Signetics have reorganized, creating a structure that will "hopefully allow us to streamline our operations, and make sure we are in areas where we can win," says Dykes. Hagmeister adds: "We had to restructure. We were not getting out of this business what we wanted. We were not moving forward."

Dykes and Hagmeister, both new to their positions, presumably are part of the restructuring — aimed at restoring Philips to glory. Part of restoring Philips will mean the eventual demise of "Signetics" as a name brand. Although neither Hagmeister nor Dykes will say just when the Signetics name will be replaced by Philips Components, it does not seem likely before some time next year.

So now the company is divided along product lines, with corporate headquarters in The Netherlands retaining responsibility for four product areas, and the U.S. operation for three. Dykes explains: "It just makes sense to put product development and R&D where it can best be used. I don't have any business doing research on new standard logic products, but I should be developing new

Takeover mania leaves Plessey dangling

Plessey Semiconductor Ltd. is having a tough time right now — and not just in the United States.

Caught up in merger/acquisition mania, The Plessey Company Plc has spent the long summer waiting to see whether Britain's General Electric Co. and Siemens AG will succeed in a bid to acquire it. GEC and Siemens each hope to acquire 50% of the British conglomerate.

Informed speculation from analysts and other inside sources does give GEC and Siemens the likelihood of succeeding in the takeover bid next month, leaving Plessey's chip group in a precarious position.

Published reports in Britain have said Doug Dunn, the semiconductor managing director, and his management team intend to lead a buyout of the chip operation from GEC/Siemens if the takeover succeeds; those same published reports indicate that GEC and Siemens would be willing to listen to the proposal.

But Dunn is only willing to say that a management buyout would represent "a last ditch stand to retain an independent Plessey Semiconductor, and I have not talked to GEC and Siemens about it."

So right now, Plessey's U.S. plans are somewhat nebulous.

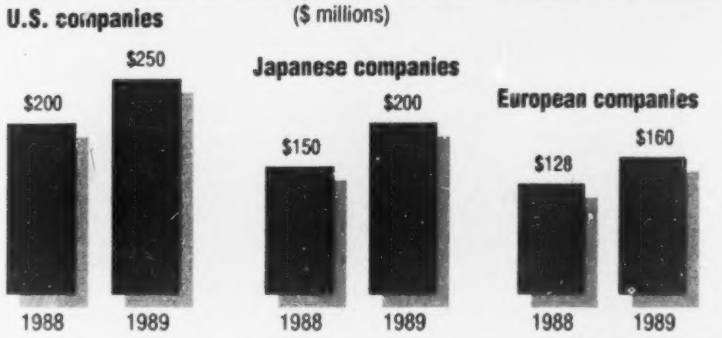
With a manufacturing facility in Scotts Valley, Calif., and $65 million in sales last year, Plessey has slowly begun to penetrate the U.S. market. Dunn has put more people in sales in the U.S. over the last year than ever before. They have, in the words of U.S. marketing director Philip Pollock, "established a beachhead."

But for Dunn, it is not enough. "We need to get to a critical mass of around $200 million," he stresses. "It is not enough to be seen as a persistent visitor. We must be a resident."

To become a resident, Plessey intends to expand its product line, "not deepen it," Dunn says, and leverage its strengths as a broadline ASIC supplier in both CMOS and bipolar. The key will be a relationship with another U.S. supplier.

Dunn is optimistic for the future. "We spend like an American company in terms of R&D and sales and marketing and we don't need to be like a TI or a Motorola. The U.S. market is open and receptive to British technology. The Americans just need to commit to one or two suppliers and stick with them. That's all we need." ☐

Semiconductor capital spending in the U.S.



Source: Dataquest Inc.

programmable logic devices.”

A telling sidelight to this strategy: under the restructuring, the beleagured SRAM product line — which has yet to yield any U.S. product — will report directly to Hagmeister, a sign, certainly, of its importance to the company.

“We can't continue at the rate we were going,” Dykes stresses. Now the company, which has reduced its workforce over the last few years to 8,500, plans to play to its strengths in the EDP and automotive markets — particularly automotive — where Signetics has lost ground of late, Dykes says.

For Siemens, the vehicle to success in America may lie in partnering, which all three European concerns are doing to some degree. Siemens alone has agreements with Intel Corp.; Mips Computer Systems Inc.; Toshiba Ltd.; and Advanced Micro Devices Inc., which Siemens also owns a piece of.

Philips has arrangements with Motorola Inc. and VLSI Technology Inc., as well as an as-yet-unnamed microprocessor supplier. SGS-Thomson has a relationship with National Semiconductor Corp., and appears to be shopping for a microprocessor relationship as well, and maybe a DRAM partner or two.

Behind every one of these relationships is a desire by the Europeans to offer a broad category of parts to customers. “The biggest challenge in the American market is having a broad catalog of products,” says Hagmeister. “It is a minimum to compete to have a broad line of products. There are vendor reductions going on. You have to have a broad range.”

For Siemens in particular, which hopes to attract big U.S. multinationals as customers, this broad category of products is vital. “When you have the central processor in a system, it opens you up to selling all the things that go around it,” says Iselin, New Jersey-based Siemens Components president and CEO Wilfried Backes of the company's plans to offer the Mips processor. So when Siemens wants to sell to its customer Digital Equipment Corp., it can do so with a broad catalog, and offer the added bonus of supplying DEC around the world, says Backes.

But for now, Siemens hopes this strategy of appealing to internationally minded companies will help offset its lack of a wafer fab in the United States.

Must market or die

Despite all of these lofty plans in place, the Europeans still must live down their reputations as “marketing-adverse” companies.

“We don't see their salesforce at all,” says Hewlett-Packard Co.'s director of corporate purchasing Gene Richter. “They don't have a big engineering or technical market presence. They are doing something about that now, but it looks like [in the past] they haven't tried that hard here. There hasn't been a lot of concentration on this market.”

“There was no clear identity in the past as to what their product strategies were,” adds Dataquest's de Dios.

This lack of focus, combined with

Who will “Europeanize” the U.S.? The winner is . . .

With the battle lines drawn, and the sides chosen, it is difficult to determine which European chip company is likely to come out on top in the battle to “Europeanize” the United States.

N.V. Philips GL, SGS-Thomson Microelectronics and Siemens AG all offer some rather potent strengths and weaknesses.

And although an informal ELECTRONIC BUSINESS poll of the “most likely to succeed” was split between SGS-Thomson and Siemens, one element is clear: He who wins must have memories and microprocessors.

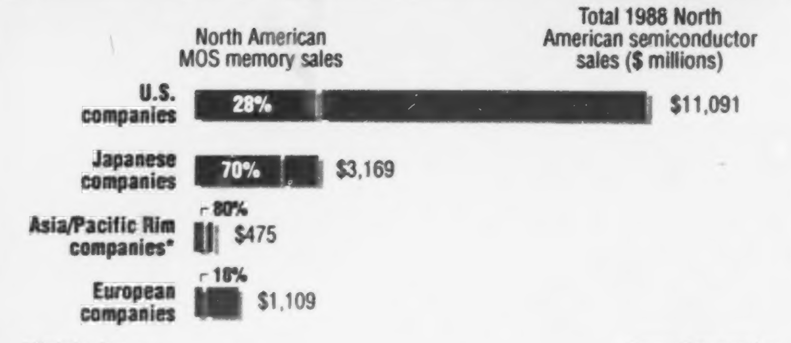
To date, the Europeans have had almost no presence in the two fastest growing markets — 32-bit microprocessors and memories. Siemens, for example, has been selling 1Mb DRAMs for more than a year, but says the products represent less than 5% of total 1988 sales. Numbers from market research company Dataquest Inc. show that Siemens sold only $9 million worth of DRAMs in the U.S. last year, a small number for a year when the market was in shortage. But undoubtedly Siemens is a motivated DRAM supplier. Company executives estimate almost $500 million was spent on acquiring the technology and putting the fab facility in place.

Philips, meanwhile, after investing hundreds of millions of dollars in SRAMs in the MEGA Project with Siemens, has yet to ship any static RAMs in the United States at all. Although Signetics Corp. president James Dykes is optimistic about his future in the SRAM business, he is concerned: “We have not abandoned the SRAM market. There are a lot of marbles bet on that piece. It's not too late if we can execute.” Signetics should start shipping its SRAMs in the fourth quarter of 1989, Dykes says.

SGS-Thomson has only a minor presence in SRAMs ($24 million in the United States last year), but that is an area targeted for increased growth in the years to come, says United States-based president Daniel Queyssac.

Neither Philips nor SGS-Thomson have any kind of significant presence in the 32-bit microprocessor market. Philips is expected to sign a second-source agreement with

U.S. MOS memory market breakdown



* Excludes Japan

Source: Dataquest Inc.

sporadic marketing efforts in the past has harmed European reputations. Signetics, in particular, has suffered, Dykes says. "After the acquisition by Philips, there was a long period of waiting here, waiting to see what the change in strategy would be." When that happened, development still continued, but the company's presence in Silicon Valley wavered. Now, Dykes says, the time has come to refocus and restructure.

Customers, however, remain leery of the Europeans' new attention to marketing. Siemens, one major DRAM workstation customer says, is now "taking steps in the right direction." Nonetheless, that same customer questions whether Siemens has the business plan, self confidence or organizational structure to "really take on the U.S. marketplace."

Such an attitude among customers that they are poor marketers is not all the Europeans must contend with. The biggest hurdle to overcome in the United States is a perceived lack of technology. "I don't see them as state of the art," contends one purchasing manager of a large U.S. computer company. "The Europeans are not driving the technology."

From weak product lines, to nonexistent or substandard manufacturing, to out-of-date products, the Europeans have trailed both the Americans and Japanese in the race for technology leadership. And it is more than just the fact that the Europeans are weak in memories and microprocessors. It is that they have not viewed the markets and the customers the same way as the Americans, and that they are not structured to exploit opportunities.

In the two key ways to judge technology leadership — capital spending and research and development dollars — the Europeans lag behind both the Americans and the Japanese.

In terms of capital expenditures, the Europeans dramatically underspend both U.S. and Japanese companies, both in the United States and worldwide. According to Dataquest, Europeans spent $128 million on capital equipment in the United States last year, while Japanese companies spent more than $150 million and American companies spent more than $200 million. Worldwide, European capital spending accounted for well less than 10% of the $10 billion total last year. In fact, the Europeans spent only $788 million on capital equipment worldwide last year.

Next year, European companies are expected to spend about $160 million, while the Japanese will spend well in excess of $200 million in the United States. Europe's kind of capital spending commitment does not make for technology leadership, semiconductor market analysts agree.

In terms of manufacturing presence, the Europeans look weak in comparison with others. Signetics, for example, has five fabs in the United States, but only three are state of the art, 1.5 micron or better. The Japanese, on the other hand, have no fabs in the United States over 1.5 micron, and companies such as NEC Corp. are expanding their existing fabs. Siemens does not have a U.S. manufacturing presence at all, al-

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a 32-bit vendor; the most likely candidate is speculated to be Motorola Inc. SGS-Thomson is fielding Inmos Ltd.'s Transputer, but as corporate marketing vice president Philippe Geyres readily admits, it is somewhat of a niche product.

Siemens is the only one of the three to offer a reasonable 32-bit candidate — in the shape of Mips Computer Systems Inc.'s 3000 microprocessor.

But disregarding, for the moment, products, the intangibles enter into the decision — such as personality. Those favoring SGS-Thomson to "Europeanize" the United States (and they include customers, some analysts and some European companies) give colorful and charismatic chairman Pasquale Pistorio the edge hands down.

"Pistorio will brute force that company to the top," says one analyst. "I would give SGS-Thomson the nod just on the strength of his personality."

"Pistorio is the one person who really seems to know what he is doing in the marketplace with the marketing," says Integrated Circuit Engineering Inc. analyst William J. McLean.

And purely from a numbers perspective, SGS-Thomson is a safe bet. The only company to increase its market share in 1988, SGS-Thomson is executing on its strategy. The company, however, is in the weakest product position, with no mainstream DRAM or 32-bit technology to field.

The other strong candidate is Siemens. "Siemens is giving us high quality 1Mb DRAMs today," according to Sun Microsystems Inc.'s purchasing manager Scott Metcalfe. "They are right up there with the Japanese."

And certainly in terms of technology, Siemens appears to be in a strong position, with both DRAMs and the Mips processor as aces in the hole. A lack of U.S. manufacturing is a downside, however, and some customers feel that the company lacks "presence."

Siemens Components' CEO Wilfried Backes agrees. "Siemens is not a household word here," he quotes. "That is one of the things that really holds us back." Nonetheless, several analysts and Siemens customers would give them the vote in the battle for the New World. Says one customer: "I'd give it to Siemens. They've proven they can do DRAMs in high volumes. That's a big step." ☐

though the company is still debating the wisdom of putting a quick-turn ASIC fab in its Santa Clara, Calif., headquarters.

And perhaps most revealing of all, the Europeans have not kept the pace in research and development spending in the past. European R&D spending is on the whole lower than the U.S. average of 18%, ranging from 8% at SGS-Thomson to a high of 15% at Signetics. Siemens spends 9% per year of U.S. sales on R&D, but all these companies are outspent by most American competitors since the U.S. firms are so much larger.

Techno-lag

How far do Europeans really lag behind the Americans and Japanese? SGS-Thomson's Geyres flatly states: "There is no lag. We have the submicron fabs, we have the processes. There is no lag." However, analysts' estimates range from a six-month lag to almost two years. Certainly, the Europeans were not first with either 32-bit processors or 1Mb DRAMs, one technology indicator.

And European companies are not developing the technology on their own, as shown by Siemens, which was forced to resort to licensing its DRAM technology from Toshiba Corp. This happened as well with some of its gate array and standard cell technology.

The Europeans are not quick to move on new processes either. Right now, some European companies are suffering for their slow move into CMOS, and companies such as Philips/Signetics are "still primarily a bipolar house," admits Dykes.

This hurts the Europeans in two ways. First, it limits their ability to go after high-growth markets, like ASICs, says LSI Logic Inc. president George Wells. "The Europeans aren't strong in CMOS, and they have lagged in ASICs, probably because they have such a strong bent toward bipolar. We don't see them as competition at all." Secondly, it traps them into such high-volume, low-price commodity businesses as standard logic. "There is a $500 million dead weight there [at Philips] in standard logic," notes Integrated Circuit Engineering Inc.'s market research manager William J. McLean.

The Europeans are being outpaced by the upstart Koreans

This situation is endemic to the Europeans, critics say: great R&D, but poor implementation. "I am convinced those companies have the technology in the bowels of their operations," McLean states. "But you just don't see it get out."

And in some cases, you just don't see it. Siemens, for example, developed its own 32-bit RISC processor, but decided that "we just couldn't market it with any success, even in Europe," components executive Horstman admits. So the company cut a deal with Mips of Sunnyvale, Calif., for its 3000 processor.

"There never has been in Europe the same entrepreneurial environment we have had here," Signetics' Dykes explains. "A lot of the advancement in the U.S. market has been a result of entrepreneurial activities."

"The Europeans don't have productive product development machinery yet," adds Intel Corp. executive vice president and general manager David House. "They haven't developed the Silicon Valley spirit. They are not nimble on their feet. I've watched the Europeans try and take on the U.S. market before. There is nothing new in this. Ninety percent of our [competitive] problems come from across the other ocean."

The other big disadvantage for the Europeans is the small size of their computer industry — approximately one half the size of the U.S. systems market of $64.3 billion in 1988. While computers are a driving technology force in the United States — the largest single semiconductor market outside of the military — in Europe, telecommunications is a bigger market and tends to be the prime technology driver. Thus, European companies in the United States are often unprepared for the kind of technology demands placed on them.

Despite all these obstacles, it is clear that the Europeans must make a dent in the U.S. market now. If not, they will have lost forever the opportunity to call themselves "global."

"You can't ignore America if you are a large chip supplier," SGS-Thomson's Geyres says, reflecting a sentiment all the Europeans share. "We will do whatever we have to do. We will be cautious."

But he is optimistic, too. Speaking about such companies as Texas Instruments Inc. and Motorola Inc., both of which have successful European operations, Geyres finds hope. "We are more American than they are European," he says. "We can do it, too." ☐

Siemens vs. NEC: Gauging U.S. success

One way to judge just how well the Europeans have executed in the United States is to compare them with, say, the Japanese.

With language and cultural barriers far greater than those of the Europeans, the Japanese should be hampered in their drive on the U.S. market. However, Dataquest Inc. market share data gives the Japanese 20% of the U.S. market, while the Europeans are staying steady at 7%.

According to analysts, the two best comparisons can be made between NEC Corp. and Siemens AG.

"Siemens is not like NEC," disagrees Integrated Circuit Engineering Inc.'s William J. McLean. "They don't have enough emphasis on top on semiconductors. There is a big difference between the two."

But is there?

Both companies started "seriously" selling ICs in the United States in the early 1980s. NEC's U.S. sales represent 10% of its total revenue, while Siemens, by its own admission, attributes less than 1% of its worldwide sales to the United States.

NEC has one Class 10 fab in Roseville, Calif.; Siemens has no manufacturing capacity to date. NEC also recently announced it is doubling the size of its Roseville plant. ☐

"Do or die" time confronts Schlumberger

Behind the leadership of test veteran Irwin Pfister, this former ATE titan aims to restore customer confidence — and slipping market share

BY TONY GREENE

Sharper focus. That's the key to the new strategy of once-dominant Schlumberger Technologies ATE division — brought to bear through one executive, Irwin H. Pfister, now three years as vice president/general manager of the Schlumberger Ltd. unit.

Balancing on the edge of his chair, Pfister waves his hands vigorously in the air to emphasize his point. "Three years ago when Schlumberger gave me this job, my mission was to pump air into the body. I didn't realize the body wasn't breathing," Pfister says in his characteristically direct manner. "We were overstaffed, we had no new product, we weren't visiting our customers, we had three manufacturing sites, and we had three development sites. Do you need anything else!"

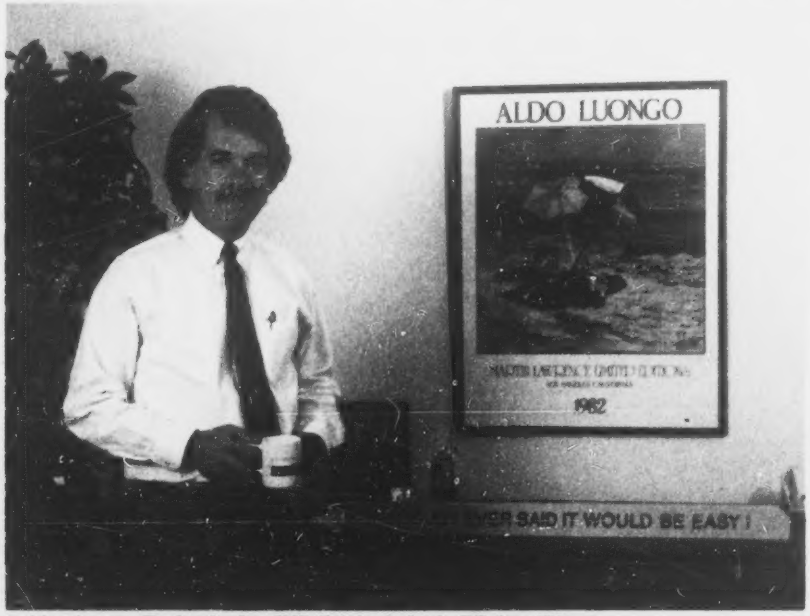
That desire for focus drives Pfister; he prefers giving an interview in the peace of his hotel room because he finds restaurants too distracting, and "you can't get any business done."

With 13 years of management experience in the electronics industry before coming to Schlumberger, Pfister brought to the company a severely needed understanding of the ATE business; most recently he served as vice president for marketing, vice president for engineering, and general manager of ATE vendor Computer Automation Inc.'s industrial products division. "I've been in the service business my entire career," he says. "Schlumberger was in the test equipment business. They were just taking orders and shipping goods."

Now, San Jose-based Schlumberger ATE is focusing on "bringing hardware and software solutions to engineering problems." But to do so it must maintain its dwindling market share and improve the quality of its products and service while still bringing new product to the market.

It is a focus Schlumberger needs. In May 1986, Pfister was handed the reins of a company that at one time dominated its industry. When the ATE market peaked at $1.8 billion in 1984 and 1985, a level it did not reach again until 1988, when it passed $2.1 billion, Schlumberger had a 17% share with revenue of $311 million. That percentage has since slipped, reaching its lowest point in 1988 when Schlumberger had a 10% share with revenue of $220 million.

The downturn in Schlumberger ATE's fortunes was painfully apparent to the company when Pfister came aboard. Schlumberger was seeing a massive defection of its customer base as products such as the Sentry 50 IC tester were late to market and did not meet customer requirements. Customers were unable to get the fault coverage and throughput they needed. In the cutthroat ATE world, competitors, such as Boston-based Teradyne Inc. and LTX Corp. of Westwood, Mass., were quick to move in and carve up the available market share. "It was obvious we weren't listening to or talking to our customers," says Pfister.


ALDO LUONGO
1982
SAID IT WOULD BE EASY !

Schlumberger Technologies ATE division's Irwin Pfister: "It was obvious we weren't listening to or talking to our customers"

Linda Sue Scott

Alienated customers

Schlumberger alienated customers who spent millions of dollars on its ATE equipment and software by telling them they needed new testers and software that were incompatible with existing Schlumberger systems. Customers were also told they would have to wait for the systems. "We went away from Schlumberger in 1984-1985 because of their lack of willingness to work with customers. They were arrogant," says L.J. Reed, vice president and general manager of Motorola Inc.'s ASICs division.

Motorola needed to stay with Schlumberger and the Sentry 50 because the investment Motorola made in software development began a year before the first system was to be delivered. "The machine had technical problems, and they couldn't deliver it," says Reed. "Schlumberger's attitude was, 'Yes, I'm late and you're going to have to wait.' We didn't see the kind of urgency that should have been there." Reed says Motorola could not ship product because the tester had not arrived. Ultimately, an estranged Motorola quit Schlumberger and bought LTX testers.

While some observers attribute Schlumberger's decline in the ATE arena solely to its market blunders, others say the problems ran deeper. "Schlumberger didn't understand the ATE industry," says industry analyst Kenneth Neff of the San Jose market research firm Prime Data.

Industry watchers say Schlumberger, incorporated in the Netherlands Antilles, did not understand the electronics industry in general. They point to the 1987 sale of Fairchild Semiconductor at a loss of $220 million as an admission of defeat in the highly competitive semiconductor market. The fact that Schlumberger's ATE operation has borne four names in the last 10 years — from Fairchild ATE in the early 1980s to Schlumberger Technologies ATE division today — has left an already jittery customer base that is confused and concerned about the company's commitment to ATE. Pfister has a straightforward reply to alleviate these problems: "The recipe [to fix it] is simple. You make a commitment to your customer and you fulfill it, and you go back and make another commitment and do it again."

Quick to take concrete action to eradicate customers' confusion over the name changes, Pfister is replacing the nameplates. "We're going to have a conscious effort with each sales guy. He is going to go out and take the old name plate and replace it with one that says Schlumberger Technologies," says Pfister.

Improved employee training

This kind of decisive action is indicative of the strategy guiding Schlumberger Technologies' ATE. Since taking over, Pfister has cut the 2,000 employee domestic staff in half. Schlumberger also has closed all three of its original manufacturing facilities to build one highly automated, quality-intensive facility in Simi Valley, Calif. In addition, research and development was concentrated in one facility in San Jose.

Pfister brought to the company a severely needed understanding of the ATE business

Having set quality in product, service and support as a linchpin to its strategy, Schlumberger ATE is seeking to give its employees the skills needed to carry it out. "The key is training and educating the people. We teach them how to identify a problem and give them the tools to deal with it," says Pfister. Schlumberger ATE allocates 20% of each employee's time during the first six to nine months of hire to quality training using an interactive 161-page training manual. After the initial period, each employee spends about two hours a week on quality issues.

"When I first came in here," Pfister says, "[employees] believed if you didn't have the latest, greatest product, the customer didn't want to see you. Today, I think the organization believes in more than product. They do what the customer needs them to do."

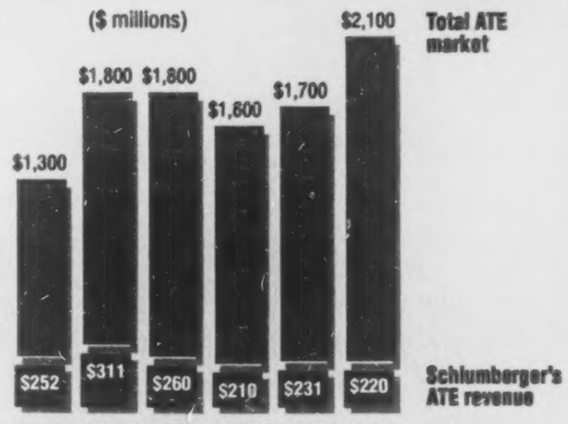
Customers that were once critical of Schlumberger are beginning to see the change. "I really believe that you can use Schlumberger's ATE group as a model of what needs to be done in this country," Motorola's Reed says now. "Their attitude is to give the customer what they want, not what [Schlumberger] has." In May, Motorola awarded Schlumberger $8 million as part of a joint development program for a new type of high-speed high-pincount ATE machine.

Yet, despite Motorola's affirmation of Schlumberger ATE, the battle for Schlumberger to regain market share and revenue continues. "For us right now, Trillium, [LTX] and Teradyne are the companies we focus on. Schlumberger would be a second tier consideration," says Howard High, strategic communications manager for Intel Corp.

One way to get out of the second tier is with new products. Schlumberger is introducting five new product families this year, ranging in price from $200,000 to $1.4 million. "It is do or die on these new products," says Shearson Lehman Hutton Inc. analyst Steven Balog. Pfister says Schlumberger is primed to meet such a challenge: "The business is a hell of a lot healthier than it was three years ago."

"Schlumberger has an advantage. Even though they are huge in the market, they are kind of sneaking in. It seems that the competition is not concerned about them," says Hambrecht & Quist analyst Carolyn Rogers. That is an attitude that Schlumberger has already learned is dangerous to have. ☐

Schlumberger's ATE market share



* Does not include Schlumberger's revenue from its IDS 5000 E-beam prober

Source: Prime Data

Top 100 R&D spenders increase investment by 15.7%

Exclusive ELECTRONIC BUSINESS ranking reveals a collective $18.2 billion spent on R&D by the top 100 in 1988. Software firms post the highest rates

BY BRUCE C.P. RAYNER
and LINDA STALLMANN

There were no great surprises on the ELECTRONIC BUSINESS 1988 list of the top 100 research and development spenders in the electronics industry. Total R&D spending saw a double-digit percentage increase in 1988 over 1987, while R&D spending as a percentage of sales rose nominally. Software companies posted the highest rates of R&D spending, with four firms making the top 10, up from two last year.

Combined, the top 100 companies spent $18.2 billion on R&D in 1988, a 15.7% increase from the $15.7 billion logged in 1987. That mirrors a rise in sales for the same 100 companies of 15.4%, from $182.1 billion in 1987 to $210 billion in 1988. In the key category of R&D spending as a percentage of sales, the figure for the top 100 electronics companies rose from 8.6% in 1987 to 8.7% last year.

The top 100 R&D spenders is an exclusive ranking compiled by ELECTRONIC BUSINESS from United States-based publicly held companies in the electronics industry. To qualify, a company must derive at least 70% of its sales from electronics and be listed in the ELECTRONIC BUSINESS 200 [ELECTRONIC BUSINESS, July 24, 1989].

There were some companies that rose in the ranks and some that fell. Management Science America Inc., ranked No. 2, is making its first appearance this year. Dropping precipitously were Applied Materials Inc., down to No. 21 from No. 4 last year, and Intel Corp., which fell to the No. 31 spot from No. 11 in 1987.

But despite the usual ups and downs, there is some cause for concern with the underlying fundamentals of the top R&D performers in 1988. Cullinet Software Inc. is the top-ranked R&D spender for the second consecutive year. A developer of IBM mainframe software, Cullinet spent a robust 24.2% of its $217 million in sales on new product development. But the company's heavy R&D spending contributed to two years of red ink on its bottom line.

Top U.S. R&D spenders

Rank 1988	Rank 1987	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Industry segment
1	1	**Cullinet Software**	24.2%	$52.4	Software
2	—	**Management Science America**	23.6%	58.9	Software
3	2	**Advanced Micro Devices**	18.5%	208.3	Semiconductors
4	3	**LTX**	18.1%	31.6	Capital equipment
5	8	**Lotus Development**	17.9%	83.8	Software
6	37	**Ashton-Tate**	17.2%	52.9	Software
7	6	**Cray Research**	15.6%	117.8	Mainframes
8	—	**Integrated Device Technology**	15.5%	18.8	Semiconductors
9	9	**Tektronix**	15.3%	215.6	Capital equipment
10	12	**GenRad**	14.9%	30.7	Capital equipment
11	7	**Analog Devices**	13.8%	60.5	Semiconductors
12	5	**Teradyne**	13.4%	61.9	Capital equipment
13	15	**Sun Microsystems**	13.3%	139.9	Minicomputers
14	13	**DSC Communications**	13.2%	45.0	Communications
15	—	**Chips & Technologies**	13.2%	18.7	Semiconductors

Fiscal 1988 figures

Source: ELECTRONIC BUSINESS

(Cullinet will never appear in our ranking again. It was bought in June by 25th-ranked Computer Associates International, also an IBM mainframe software company, for an estimated $320 million.)

Even meteoric Management Science America, a major software company, has its share of problems. MSA scrambled to reposition itself in the world of IBM's new Systems Application Architecture by spending heavily on product development last year. As a result, it reported losses of $33.6 million in its latest fiscal year ended December 1988.

Likewise, fourth-ranked automated test equipment maker LTX Corp. has been unprofitable in the first half of its 1989 fiscal year. And Cray Research Inc., ranked seventh, is restructuring and scaling down some of its R&D effort.

Is the combination of poor performance and high R&D spending a trend? Probably not. Sound financial health and high R&D spending do not necessarily go hand in hand. Indeed, good performance can lead to *lower* R&D spending. At least that is what happened at Advanced Micro Devices Inc.

Top-ranked in our R&D listing in 1986, AMD dropped to third place this year, spending about 18.5% of its sales on R&D, down from 30% two years earlier. The reason is threefold, according to a company official: the merger with Monolithic Memo-

Top U.S. R&D spenders

Total R&D spending

($ millions)

IBM	$5,925
Digital Equipment	1,307
Hewlett-Packard	1,019
Xerox	794
Unisys	713
Motorola	665
GM Hughes Electronics	551
Texas Instruments	494
NCR	416
Control Data	336
Honeywell	323
Intel	318
National Semiconductor	280
Apple Computer	273
Wang Laboratories	246

R&D spending per employee

Chips & Technologies	$60,828
Ashton-Tate	42,290
Lotus Development	33,535
Amdahl	26,626
Apple Computer	25,233
Microsoft	24,982
MSA	24,874
Applied Materials	24,633
Quantum	23,754
Cray Research	22,485
LTX	22,376
Cullinet Software	21,830
Mentor Graphics	19,786
Sun Microsystems	19,733
Tandem Computers	19,638

R&D spending growth

Percentage change from 1987

Oracle Systems	226.4%
Chips & Technologies	167.3%
Conner Peripherals	144.0%
Computer Associates	103.2%
Sun Microsystems	101.1%
Loral	100.7%
Maxtor	90.4%
Ashton-Tate	88.9%
Everex Systems	86.4%
Microsoft	83.3%
Western Digital	81.1%
Wyse Technology	74.3%
3Com	69.8%
Stratus Computer	61.6%
Novell	60.5%

Fiscal 1988 figures

Source: ELECTRONIC BUSINESS

ries Inc. in 1987 resulted in R&D redundancies and better leverage from R&D spending; leverage has also improved from the $10 million annual R&D contribution AMD makes to semiconductor consortium Sematech; and collaborative ventures with the likes of Sony Corp. and Siemens AG mean less R&D inhouse. AMD's R&D spending will stay between 15% and 20% over the long-term, the official adds.

AMD is way ahead of the competition in the semiconductor industry when it comes to R&D spending as a percentage of sales. The industry average is 9.4%. But in dollar terms, Motorola Inc., the largest U.S. chip maker, outspent them all with $665 million in 1988, up from $524 million in 1987.

While Motorola's R&D investment is significant, it is dwarfed by IBM's budget. IBM spent only 10% of sales for R&D, but that represents $5.925 billion. Big Blue alone accounts for 32.6% of the total R&D spending by the ELECTRONIC BUSINESS 100 top R&D spenders, outdistancing Digital Equipment Corp., its closest R&D rival by more than four times.

Oracle Systems Corp., a database management software company, might not be an IBM, but it tops the fastest growing list with a whopping 226.4% growth in 1988 spending over 1987. This is almost double the growth of Genicom Corp., the fastest growth leader in 1987, which posted a growth rate of 143.3%.

But Oracle's R&D growth is somewhat overstated. According to company financial statements, 1987's R&D spending was adjusted downward due to an accounting change in the capitalization of software development costs, thus making the growth rate between the two years higher. Nonetheless, the increase is still impressive. The company spent $7.48 million or 13.5% of its sales on R&D in 1986, $9.95 million in 1987, and $25.7 million in 1988.

Software companies posted the highest rates of R&D spending with four firms making the top 10

Is U.S. spending sufficient?

Is the U.S. electronics industry spending enough on research and development? The answer is uncertain, because up-to-date comparative figures are hard to come by. The U.S. electronics industry as a whole spent an estimated $60 billion in 1988 on R&D, of which about $33 billion was spent by the high-technology sector, excluding chemicals, according to the National Science Foundation (NSF). The ELECTRONIC BUSINESS top 100 accounts for about 55% of the industry's total.

Comparatively, U.S. industry spends more on R&D than Japan, France, Britain and Germany combined, says Carlos Kruytbosch, director for scientific indicators at the NSF. But in terms of a percentage of Gross National Product, the United States is running fairly evenly with all four. In fact, Kruytbosch says, U.S. industry's spending as a percentage of GNP is declining every year, while the same figure for the major trading partners is increasing.

But total dollar spending is not necessarily the critical issue, says Martyn Roetter, manager of information industry service at the consulting firm of Arthur D. Little Inc. "It is not so much whether or not the absolute level of R&D is right but whether those resources are being applied correctly," he says.

Improving efficiency of R&D funds includes speeding up development time and adopting some of Japan's development methods. That includes integrating manufacturing, design and even marketing into the development phase of the product. Roetter says one of the key issues with high-tech companies today is how they can improve the productivity of R&D funds. ☐

Top U.S. R&D spenders

Rank 1988	Rank 1987	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Change from 1987	Fiscal 1988 revenue ($ millions)	Change from 1987	Fiscal 1988 net income ($ millions)	Change from 1987	Fiscal year ended
1	1	**Cullinet Software**	24.2%	$52.4	4.9%	$216.7	23.9%	-$47.0	NM	4/88
2	—	**Management Science America**	23.6%	58.9	11.8%	250.0	-3.3%	-33.6	NM	12/88
3	2	**Advanced Micro Devices**	18.5%	208.3	-15.9%	1,125.9	12.9%	19.3	NM	12/88
4	3	**LTX**	18.1%	31.6	36.3%	174.8	44.9%	7.0	NM	7/88
5	8	**Lotus Development**	17.9%	83.8	43.5%	468.5	18.4%	58.9	-18.2%	12/88
6	37	**Ashton-Tate**	17.2%	52.9	88.9%	307.3	14.9%	47.8	10.9%	1/89
7	6	**Cray Research**	15.6%	117.8	8.2%	756.3	10.0%	156.6	6.5%	12/88
8	—	**Integrated Device Technology**	15.5%	18.8	32.7%	121.1	55.6%	11.6	351.6%	3/88
9	9	**Tektronix**	15.3%	215.6	8.0%	1,411.9	1.1%	-16.7	NM	5/88
10	12	**GenRad**	14.9%	30.7	16.2%	205.9	6.2%	-6.2	NM	12/88
11	7	**Analog Devices**	13.8%	60.5	8.0%	439.2	18.6%	38.0	103.4%	10/88
12	5	**Teradyne**	13.4%	61.9	0.7%	462.3	22.4%	-3.3	NM	12/88
13	15	**Sun Microsystems**	13.3%	139.9	101.1%	1,051.6	95.6%	66.4	83.0%	6/88
14	13	**DSC Communications**	13.2%	45.0	10.0%	339.7	8.7%	20.0	37.4%	12/88
15	—	**Chips & Technologies**	13.2%	18.7	167.3%	141.5	76.3%	22.1	71.2%	6/88
16	36	**Tandem Computers**	12.9%	169.4	56.1%	1,314.7	27.0%	94.5	-10.5%	9/88
17	19	**Amdahl**	12.3%	221.0	23.5%	1,801.8	19.7%	213.8	50.6%	12/88
18	—	**Concurrent Computer**	12.2%	32.0	29.4%	263.1	6.2%	14.4	83.0%	6/88
19	17	**Data General**	12.1%	165.2	3.6%	1,364.7	7.1%	-15.5	NM	9/88
20	16	**General DataComm**	12.1%	23.3	-8.0%	192.2	-4.2%	-18.4	NM	9/88
21	4	**Applied Materials**	12.0%	43.5	39.3%	362.8	108.0%	40.0	NM	10/88
22	30	**Microsoft**	11.8%	69.8	83.3%	590.8	70.8%	123.9	72.4%	6/88
23	28	**Apollo Computer**	11.8%	76.9	25.9%	653.5	18.0%	0.2	-98.9%	12/88
24	38	**Stratus Computer**	11.5%	30.6	61.6%	265.3	44.1%	29.3	51.3%	12/88
25	14	**Computer Associates**	11.5%	81.5	103.2%	709.1	129.3%	101.8	179.0%	3/88
26	33	**Digital Equipment**	11.4%	1,306.5	29.3%	11,475.5	22.2%	1,305.6	14.8%	6/88
27	20	**National Semiconductor**	11.3%	280.2	28.0%	2,469.7	32.2%	62.7	NM	5/88
28	21	**Digital Communications**	11.3%	25.7	21.8%	227.5	25.4%	42.2	56.2%	6/88
29	31	**Mentor Graphics**	11.2%	33.8	39.8%	300.8	35.6%	33.5	65.0%	12/88
30	34	**Intergraph**	11.1%	89.2	32.2%	800.2	24.8%	88.0	25.9%	12/88
31	11	**Intel**	11.1%	318.3	22.5%	2,874.8	50.7%	452.9	158.0%	12/88
32	23	**Prime Computer**	10.9%	174.3	58.9%	1,594.6	65.9%	13.0	-80.0%	12/88
33	25	**Coherent**	10.5%	19.7	9.5%	188.1	18.3%	-1.3	NM	9/88
34	32	**Fluke**	10.4%	23.4	5.5%	224.5	8.8%	12.4	519.4%	9/88
35	27	**Hewlett-Packard**	10.4%	1,019.0	13.1%	9,831.0	21.5%	816.0	26.7%	10/88
36	42	**Westmark International**	10.3%	37.8	34.8%	365.3	25.1%	10.4	NM	12/88
37	40	**IBM**	9.9%	5,925.0	9.0%	59,681.0	10.1%	5,491.0	4.4%	12/88
38	29	**LSI Logic**	9.8%	37.0	27.8%	378.9	44.5%	23.8	121.9%	12/88
39	44	**ADC Telecommunications**	9.7%	17.4	12.5%	179.9	7.8%	17.0	11.1%	10/88
40	41	**VLSI Technology**	9.6%	21.2	26.2%	221.2	28.6%	6.7	-16.8%	12/88
41	26	**Cipher Data Products**	9.4%	17.4	-13.3%	185.4	4.0%	10.4	141.1%	6/88
42	46	**Dynatech**	9.4%	34.4	25.9%	367.8	20.7%	24.5	5.6%	3/88
43	50	**3Com**	9.3%	23.4	69.8%	251.9	128.3%	22.5	102.3%	5/88
44	22	**Control Data**	9.3%	335.7	-13.7%	3,628.3	7.8%	1.7	-93.2%	12/88
45	75	**Oracle Systems**	9.1%	25.7	226.4%	282.1	114.9%	42.9	174.5%	5/88
46	67	**Maxtor**	8.8%	24.0	90.4%	271.2	54.7%	14.1	-36.8%	3/88
47	48	**AMP**	8.8%	238.0	16.7%	2,699.7	16.5%	319.1	27.8%	12/88
48	55	**Western Digital**	8.8%	67.7	81.1%	768.3	66.1%	43.0	0.4%	6/88
49	35	**Perkin-Elmer**	8.5%	98.6	-29.7%	1,165.5	-12.6%	60.0	NM	7/88
50	—	**Ask Computer Systems**	8.3%	11.9	43.3%	142.4	44.9%	10.8	34.9%	6/88

NM = Not meaningful. The company lost money in the base year

(Continued)

Top U.S. R&D spenders

Rank 1988	Rank 1987	Company	R&D as a percentage of revenue	Total R&D expenditures ($ millions)	Change from 1987	Fiscal 1988 revenue ($ millions)	Change from 1987	Fiscal 1988 net income ($ millions)	Change from 1987	Fiscal year ended
51	—	**Burr-Brown**	8.3%	$14.7	19.1%	$176.7	25.8%	$11.5	169.5%	12/88
52	51	**Medtronic**	8.1%	53.1	26.1%	653.3	30.1%	86.5	17.2%	4/88
53	57	**Motorola**	8.1%	665.0	26.9%	8,250.0	23.0%	445.0	44.5%	12/88
54	59	**Micropolis**	8.0%	28.4	30.5%	353.1	22.5%	-19.4	NM	12/88
55	60	**Wang Laboratories**	8.0%	246.0	15.8%	3,068.4	8.2%	92.7	31.1%	6/88
56	58	**Texas Instruments**	7.8%	494.0	15.4%	6,294.8	12.5%	366.3	42.6%	12/88
57	45	**Applied Magnetics**	7.7%	22.7	16.3%	293.0	38.3%	23.7	66.9%	9/88
58	56	**Storage Technology**	7.7%	67.5	12.3%	874.0	16.5%	44.2	132.8%	12/88
59	68	**Dataproducts**	7.7%	26.7	19.3%	345.2	1.9%	-20.2	NM	3/88
60	62	**Measurex**	7.2%	19.2	14.8%	265.2	16.7%	37.1	38.2%	11/88
61	65	**Diasonics**	7.2%	20.3	9.9%	281.6	5.2%	9.8	-35.9%	12/88
62	73	**Unisys**	7.2%	713.0	19.4%	9,902.0	1.9%	680.6	17.8%	12/88
63	70	**NCR**	7.0%	416.4	16.8%	5,989.9	6.2%	439.3	4.8%	12/88
64	64	**Xerox**	6.9%	794.0	10.0%	11,476.0	11.2%	73.0	-87.4%	12/88
65	53	**Varian Associates**	6.9%	80.2	-0.6%	1,170.6	19.1%	27.8	29.9%	9/88
66	63	**Apple Computer**	6.7%	272.5	42.3%	4,071.4	53.0%	400.3	84.0%	9/88
67	61	**Gerber Scientific**	6.5%	17.1	3.1%	264.0	17.9%	29.6	40.6%	4/88
68	43	**Quantum**	6.4%	12.1	4.9%	188.5	56.1%	-3.2	NM	3/88
69	69	**Watkins-Johnson**	6.3%	18.3	8.0%	292.2	10.6%	20.6	20.3%	12/88
70	96	**Scientific-Atlanta**	5.9%	30.0	49.5%	508.6	2.7%	29.7	22.3%	6/88
71	79	**M/A-COM**	5.9%	25.0	2.2%	424.2	-2.7%	18.4	NM	9/88
72	—	**Everex Systems**	5.9%	15.6	86.4%	266.7	69.4%	10.5	21.8%	7/88
73	49	**TIE/communications**	5.7%	14.6	-32.0%	255.3	2.0%	-17.0	NM	12/88
74	—	**Novell**	5.7%	16.0	60.5%	281.2	53.8%	30.4	49.6%	10/88
75	76	**Cherry Electrical Products**	5.7%	11.0	14.8%	194.6	21.2%	7.4	169.8%	2/88
76	91	**Esterline**	5.7%	16.1	33.0%	284.4	9.5%	8.4	NM	10/88
77	90	**Andrew**	5.6%	14.1	35.7%	253.5	13.6%	13.9	264.5%	9/88
78	77	**Harris**	5.6%	116.9	-0.9%	2,099.3	1.0%	65.4	-22.6%	6/88
79	80	**Molex**	5.3%	26.6	25.8%	502.4	29.9%	59.3	36.5%	6/88
80	83	**Wyse Technology**	5.3%	24.2	74.3%	456.6	75.6%	28.0	54.2%	3/88
81	66	**Aydin**	5.0%	8.5	-15.6%	169.7	13.7%	8.4	-4.9%	12/88
82	87	**Sprague Technologies**	5.0%	25.1	20.7%	504.6	15.4%	13.2	266.7%	12/88
83	99	**GM Hughes Electronics**	4.9%	550.9	32.4%	11,243.6	7.3%	634.6	21.8%	12/88
84	74	**Bolt Beranek and Newman**	4.8%	14.7	2.6%	305.2	30.5%	18.1	NM	6/88
85	—	**Rexon**	4.7%	7.4	49.4%	155.5	53.4%	9.0	44.9%	9/88
86	—	**Atari**	4.7%	21.4	18.4%	452.2	24.7%	39.4	-20.3%	12/88
87	88	**Litton Industries**	4.7%	227.9	8.7%	4,863.9	10.1%	167.0	20.9%	7/88
88	95	**Honeywell**	4.5%	323.4	11.6%	7,148.3	7.0%	-434.9	NM	12/88
89	92	**Loral**	4.5%	64.1	100.7%	1,440.8	108.8%	74.3	29.4%	3/88
90	—	**Tandon**	4.4%	13.7	33.3%	309.3	7.0%	-19.9	NM	12/88
91	84	**International Rectifier**	4.3%	7.7	-4.1%	178.6	17.6%	-12.1	NM	6/88
92	89	**Kollmorgen**	4.2%	14.5	1.9%	344.8	14.5%	14.1	4840.4%	12/88
93	85	**Aug[illegible]**	4.1%	13.1	-18.6%	321.0	2.5%	-22.8	NM	12/88
94	—	**Seagate Technology**	4.0%	50.1	49.3%	1,257.0	31.2%	77.3	-44.7%	6/88
95	82	**AST Research**	3.8%	15.7	41.2%	412.7	100.4%	15.1	15.6%	6/88
96	94	**Zenith Electronics**	3.7%	100.6	-2.7%	2,685.7	13.7%	5.3	NM	12/88
97	86	**Genicom**	3.6%	10.6	-28.9%	291.4	-3.5%	1.0	-92.0%	12/88
98	100	**Compaq Computer**	3.6%	74.9	58.9%	2,065.6	68.7%	255.2	87.3%	12/88
99	72	**Datapoint**	3.5%	11.6	-39.9%	330.8	6.0%	8.0	NM	7/88
100	—	**Conner Peripherals**	3.4%	8.6	144.0%	256.6	126.6%	19.8	73.8%	12/88

NM = Not meaningful. The company lost money in the base year

(Continued)

Top U.S. R&D spenders by industry segment

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Capital equipment			
Hewlett-Packard	$1,019.0	10.4%	$11,713
Tektronix	215.6	15.3%	13,402
Perkin-Elmer	98.6	8.5%	8,984
Varian Associates	80.2	6.9%	6,798
Teradyne	61.9	13.4%	13,176
Applied Materials	43.5	12.0%	24,633
LTX	31.6	18.1%	22,376
GenRad	30.7	14.9%	15,343
Fluke	23.4	10.4%	9,763
Gerber Scientific	17.1	6.5%	9,262
Esterline	16.1	5.7%	5,328
Segment total	**$1,637.6**		
Weighted averages		**10.5%**	**$11,452**
Communications			
Motorola	$665.0	8.1%	$6,520
DSC Communications	45.0	13.2%	16,265
Dynatech	34.4	9.4%	11,250
Scientific-Atlanta	30.0	5.9%	8,720
Digital Communications	25.7	11.3%	17,922
3Com	23.4	9.3%	17,372
General DataComm	23.3	12.1%	9,692
ADC Telecommunications	17.4	9.7%	10,358
Novell	16.0	5.7%	10,104
Bolt Beranek and Newman	14.7	4.8%	4,667
TIE/communications	14.6	5.7%	9,721
Andrew	14.1	5.6%	5,274
Datapoint	11.6	3.5%	4,320
Segment total	**$935.2**		
Weighted averages		**8.0%**	**$7,209**
Components			
AMP	$238.0	8.8%	$9,876
Molex	26.6	5.3%	4,512
Sprague Technologies	25.1	5.0%	3,061
Augat	13.1	4.1%	3,639
Cherry Electrical Products	11.0	5.7%	3,895
Segment total	**$313.8**		
Weighted averages		**7.4%**	**$7,032**

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Computer-based systems			
Hewlett-Packard	$1,019.0	10.4%	$11,713
Intergraph	89.2	11.1%	12,216
Mentor Graphics	33.8	11.2%	19,786
Coherent	19.7	10.5%	11,584
Measurex	19.2	7.2%	7,323
Gerber Scientific	17.1	6.5%	9,262
Ask Computer Systems	11.9	8.3%	17,237
Segment total	**$1,209.9**		
Weighted averages		**10.3%**	**$11,761**
Government			
Motorola	$665.0	8.1%	$6,520
GM Hughes Electronics	550.9	4.9%	5,679
Texas Instruments	494.0	7.8%	6,527
Honeywell	323.4	4.5%	4,126
Litton Industries	227.9	4.7%	4,144
Harris	116.9	5.6%	5,173
Varian Associates	80.2	6.9%	6,798
Loral	64.1	4.5%	4,680
M/A-COM	25.0	5.9%	3,883
Watkins-Johnson	18.3	6.3%	5,813
Aydin	8.5	5.0%	4,238
Segment total	**$2,574.3**		
Weighted averages		**5.9%**	**$5,503**
Mainframes			
IBM	$5,925.0	9.9%	$15,306
Unisys	713.0	7.2%	7,667
NCR	416.4	7.0%	6,940
Control Data	335.7	9.3%	10,021
Amdahl	221.0	12.3%	26,626
Cray Research	117.8	15.6%	22,485
Segment total	**$7,728.9**		
Weighted averages		**9.5%**	**$13,153**
Medical			
Medtronic	$53.1	8.1%	$9,042
Westmark International	37.8	10.3%	11,701
Diasonics	20.3	7.2%	12,243
Segment total	**$111.2**		
Weighted averages		**8.6%**	**$10,333**

(Continued)

Electronic Business

Top U.S. R&D spenders by industry segment

Microcomputers

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
IBM	$5,925.0	9.9%	$15,306
Apple Computer	272.5	6.7%	25,233
Zenith Electronics	100.6	3.7%	2,794
Compaq Computer	74.9	3.6%	10,849
Atari	21.4	4.7%	12,002
AST Research	15.7	3.8%	8,718
Everex Systems	15.6	5.9%	9,759
Tandon	13.7	4.4%	9,263
Segment total	**$6,439.4**		
Weighted averages		**9.2%**	**$14,390**

Minicomputers

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
IBM	$5,925.0	9.9%	$15,306
Digital Equipment	1,306.5	11.4%	10,411
Hewlett-Packard	1,019.0	10.4%	11,713
Prime Computer	174.3	10.9%	14,070
Tandem Computers	169.4	12.9%	19,638
Data General	165.2	12.1%	10,712
Sun Microsystems	139.9	13.3%	19,733
Apollo Computer	76.9	11.8%	17,307
Concurrent Computer	32.0	12.2%	9,280
Stratus Computer	30.6	11.5%	17,860
Segment total	**$9,038.7**		
Weighted averages		**10.3%**	**$13,847**

Office equipment

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
IBM	$5,925.0	9.9%	$15,306
Xerox	794.0	6.9%	7,930
NCR	416.4	7.0%	6,940
Wang Laboratories	246.0	8.0%	7,961
Harris	116.9	5.6%	5,173
Segment total	**$7,498.3**		
Weighted averages		**9.1%**	**$12,482**

Peripherals

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Storage Technology	$67.5	7.7%	$7,940
Seagate Technology	50.1	4.0%	1,670
Micropolis	28.4	8.0%	8,876
Dataproducts	$26.7	7.7%	$7,509
Wyse Technology	24.2	5.3%	5,771
Maxtor	24.0	8.8%	7,635
Applied Magnetics	22.7	7.7%	2,401
Cipher Data Products	17.4	9.4%	8,481
AST Research	15.7	3.8%	8,718
Everex Systems	15.6	5.9%	9,759
Quantum	12.1	6.4%	23,754
Genicom	10.6	3.6%	2,875
Rexon	7.4	4.7%	6,308
Segment total	**$322.1**		
Weighted averages		**6.0%**	**$4,423**

Semiconductors

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Motorola	$665.0	8.1%	$6,520
Texas Instruments	494.0	7.8%	6,527
Intel	318.3	11.1%	15,304
National Semiconductor	280.2	11.3%	7,432
Advanced Micro Devices	208.3	18.5%	11,004
Western Digital	67.7	8.8%	10,288
Analog Devices	60.5	13.8%	11,319
LSI Logic	37.0	9.8%	11,448
VLSI Technology	21.2	9.6%	13,006
Integrated Device Technology	18.8	15.5%	14,135
Chips & Technologies	18.7	13.2%	60,828
Burr-Brown.	14.7	8.3%	9,963
International Rectifier	7.7	4.3%	3,367
Segment total	**$2,212.2**		
Weighted averages		**9.4%**	**$7,977**

Software

Fiscal 1988 R&D expenditures	Total ($ millions)	As a percentage of revenue	Per employee
Lotus Development	$83.8	17.9%	$33,535
Computer Associates	81.5	11.5%	18,230
Microsoft	69.8	11.8%	24,982
Management Science America	58.9	23.6%	24,874
Ashton-Tate	52.9	17.2%	42,290
Cullinet Software	52.4	24.2%	21,830
Oracle Systems	25.7	9.1%	11,648
Segment total	**$425.0**		
Weighted averages		**15.0%**	**$23,625**

Minisuper shakeout survivors foresee a revived market

As Digital Equipment readies its entry, buyers struggle to sort out confusion that stems from many contenders with rival technologies

BY ROBERT HAAVIND

Although the crowded, highly competitive minisupercomputer market has been in the doldrums — falling far short of its advance billings of only a couple of years ago — a strong revival is expected. Industry analysts and executives nonetheless temper their optimistic consensus with a note of caution.

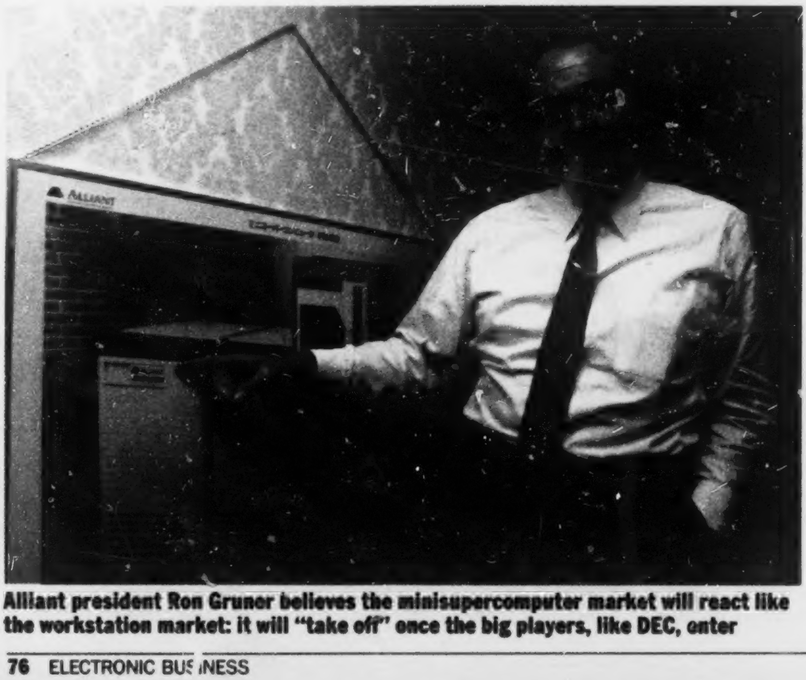
"I think the worst is over," says Jeffry Canin, an independent analyst based in San Francisco, who monitors the minisupercomputer market. But it will be another 18 months before the shakeout period comes to a complete end and good times return for the survivors, he believes.

The wild card in the market — and a major impetus for the expected resurgence — is Digital Equipment Corp. DEC is due to unveil a system with minisupercomputer performance later this year. Potential buyers of minisupers have delayed purchases until they see what DEC has to offer, vendors and analysts say.

"We look at DEC as a benchmark for the industry," says George Weiss, an analyst for the Gartner Group market research firm. If the DEC entry is viewed positively, Weiss and other observers believe, the entire field will expand and the survivors will benefit, despite competition from DEC.

Projected three years ago as an explosive market that would top $1 billion in sales by 1991, most industry watchers now agree that worldwide minisupercomputer sales have grown at a much slower rate. But analysts' estimates of the size of the minisupercomputer market vary because each defines the market a bit differently. (Gartner Group, for example, includes systems from Ardent Computer Corp. and Stellar Computer Inc. in its figures, while Dataquest Inc. includes systems from Gould Inc., even though others classify Gould computers as high-end minicomputers.

Gartner Group estimates that total sales of minisupercomputers were $335 million in 1988 and will reach $445 million this year. Dataquest senior industry analyst Chris Willard, who uses the term "departmental supercomputers" to describe the market, puts 1988 sales at $246 million. Willard believes that minisupercomputer sales will hit $838 million by 1993 — a compound annual growth rate of 27.8%


Alliant president Ron Gruner believes the minisupercomputer market will react like the workstation market: it will "take off" once the big players, like DEC, enter

Fills technical-computing niche

Minisupercomputers occupy a key niche in the technical-computing market, which makes up about 20% of the total computing marketplace, Dataquest estimates. Technical-computing applications include engineering, structural design, military systems, and scientific research. At prices ranging from $100,000 for superworkstations up to $1 million or even $2 million, the performance of minisupercomputers fits between high-end mainframes and full-fledged supercomputers.

The market for minisupercomputers came on the scene about the time the workstation market exploded in the mid-1980s. Users found that, although convenient, workstations did not have the storage capacity or computational power needed for complicated calculations.

Despite the promising outlook, the minisupercomputer market failed to take off. After fast growth in the mid-'80s, confusion in the marketplace played a major role in the slowdown, observers agree. Attracted by the projections, venture capital poured into a proliferation of start-ups. Some 20 companies were offering systems, many based on exotic architectures. Users were forced to consider assorted technology options, while no large, established companies were serving the niche. This raised concerns about maintenance and software support, and the aggregate result was delayed buying decisions.

The fierce competition forced prices down, and a number of companies had to close their doors in late 1987 and 1988, such as Culler Scientific Systems Corp. and Saxpy Computer Corp. Earlier this year, Cydrome Inc. went into Chapter 11 as a result of Prime Computer Inc. pulling the plug on its investment in the company last year. FPS Computing bought Celerity Computing, and Scientific Computer Systems Corp. of San Diego dropped its Cray-compatible minisupercomputer line. In May, Control Data Corp. shut down its subsidiary ETA Systems Inc., which sold systems from the high end of the minisupercomputer range on up.

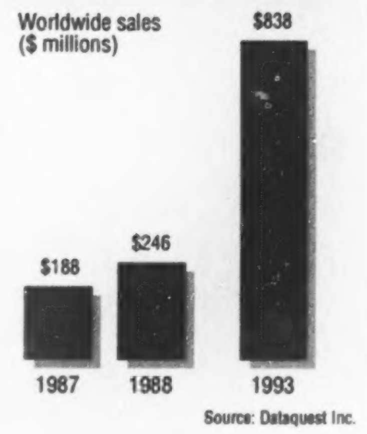
Vendors that entered the market early, that had strong marketing programs and that offered acceptable technology have the best chance for success in the shakeout, Willard says. Those that make it through the next year, he believes, will have bright prospects.

Head of the class

The market leader, Convex Computer Corp. in Richardson, Texas, continued to be profitable through last year, earning $5.7 million on sales of $105.6 million. Much of Convex's success came from its decision to offer high-end minisupercomputers, thus avoiding the bloody price battles taking place in the market. Convex sees itself competing at the low end of the supercomputer market and, in fact, now simply calls itself a supercomputer, rather than a minisuper, vendor. At the end of June, Control Data announced an agreement to sell Convex's C Series family of minisupers.

The No. 2 company, Alliant Computer Systems Corp. of Littleton, Mass., was not as fortunate as Convex, suffering losses of about $36 million on sales of $65 million. Alliant, stung by the loss of a number of key executives early last year, has returned to profitability this year after undergoing a restructuring.

Minisupercomputer market growth



Source: Dataquest Inc.

Alliant assumed a strategy different from Convex, unveiling smaller versions of its FX/Series minisupercomputers at lower prices. Although this put Alliant in the thick of the competition during the shakeout, company executives argue that the low-end systems ultimately will attract a broader market.

Unlike vendors that focus on scientific and technical markets, Multiflow Computer Inc. in Branford, Conn., has adopted a strategy that includes marketing its Trace minisupercomputers for commercial applications as well. The Trace systems are based on what Multiflow describes as a "very-long-instruction-word" architecture, which carries out multiple instructions simultaneously and so boosts performance up to 10 times that of other computer architectures without the vector processors used by its minisuper rivals.

Minisupercomputers occupy a key niche in the technical-computing market

Traditional minisupercomputer vendors are also feeling the competitive heat from marketers of "graphics supercomputers," single-user minisupercomputers with sophisticated graphics capabilities. Systems from Stellar Computer Inc. in Newton, Mass., and Ardent Computer Corp. in Sunnyvale, Calif., are in this class, as is the DN 10000 system from Apollo Computer, now a division of Hewlett-Packard Co.

Sales of single-user systems, with prices that start at about $100,000, will grow at an annual rate of 56% or more through 1993, Dataquest's Willard predicts. Minisupercomputer vendors are responding by forging alliances with manufacturers of graphics workstations or boosting the graphics capabilities of their own systems. Last year, Alliant bought out Raster Technologies Inc., a maker of graphics subsystems based in Westford, Mass., and now sells those subsystems integrated with its FX/Series minisupers.

Client-server network potential

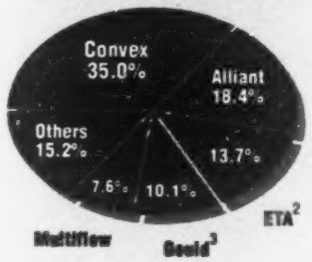
Most vendors feel there is a much larger potential for minisupers in client-server networks, where the engineer or scientist performs less demanding tasks on a local workstation, while computer-intensive work is automatically shuttled to a minisuper. As workstations proliferated, users fought the high cost of duplicating massive files at each desk with centralized "disk farms" run by file servers. Minisuper vendors see this network concept as a big opportunity.

FPS Systems was a leader in client-server networks and first offered an attached 64-bit minisupercomputer with Cray performance for less than $1 million in 1981. More recently, when it bought Celerity, FPS Systems integrated that firm's technology into its modular system and now offers Unix-based standalone processors. The emergence of standards — such as for Unix, network protocols, and graphics — will greatly simplify setting up such client-server networks, according to Craig Mundie, Alliant's vice president for research and development.

A variety of Unix-based client-server minisupercomputer offerings are contending for this emerging market. Pyramid Technology Corp. in Mountain View, Calif., for example, uses reduced instruction set computer (RISC) chips and an I/O processor in the network to speed computation and data flow. Arix Corp. (for-

Minisupercomputer makers' market share

Worldwide systems sales[1]



Total 1988 market: $246 million

[1] Excludes add-on products and service-related revenue
[2] Suspended operations April 1989
[3] Does not include Encore

Source: Dataquest Inc.

merly Arete) of San Jose uses Motorola's MC68020 microprocessor and MC68881 floating-point coprocessor, along with Unix V with multiprocessor enhancements for its expandable systems operating from 4 MIPS to 30 MIPS.

Users agree that Ethernet, widely used for data transfer, is too slow for applications in which computation and complex images must be coupled, such as for varying parameters and observing effects in a mechanical design, molecular modeling, or scientific simulation. Even though optical-fiber links have been installed in many technical-computing shops, current standards keep data transfer at the same rates as on copper wires.

Faster communications must await the Fiber Distributed Data Interface (FDDI) standard for optical data transfer expected later this year, according to Frank Vince, vice president for marketing at Convex. To help with this problem, companies such as Aptec Computer Systems Inc. in Portland, Ore., which makes a specialized I/O computer, are helping users to speed data flow among diverse peripherals, mainframes, and workstations for applications such as signal-image processing, scientific computing, and simulations such as seismic modeling for oil and gas exploration.

DEC will add legitimacy

The entry of DEC, the technical-computing leader, into the minisupercomputer marketplace will help add legitimacy to this sector, Alliant president Ron Gruner believes.

"The workstation market was not doing that well in 1985, when DEC came out with its VAXstation II and IBM introduced its RT PC, but then it took off," he argues. And, he points out, competitors of the two giants were big winners in the surging market. Stepped-up workstation buying since 1985 has taken a large portion of technical computing budgets, and as users begin to recognize the limitations of desktop systems, Gruner feels, they will want to be linked to computational engines such as minisupercomputers.

Potential customers who have delayed buying minisupercomputers while waiting for DEC to enter the minisupercomputer fray should now have a basis for making a buying decision. "It's a lot easier to benchmark against a real machine," analyst Canin notes.

Although DEC declined to discuss its plans, the Maynard, Mass., giant is expected to unveil a system — internally called Aridus — sometime this fall. By offering 30 MIPS of power per processor, the Aridus multiprocessor is expected to compete in both commercial and technical markets against other minisupercomputers.

Last month DEC said it is developing an add-on vector processor that will boost the computational capabilities of its VAX computers. IBM sells a similar product, called the 3090 VF, which increases the computational power of its 3090 mainframe.

The entry of DEC will help add legitimacy to the sector

"DEC's moves make good sense, but it appears to be planning to compete more against IBM than the minisupers," Convex's Vince suggests. As ETA Systems was leaving the market, Convex raised the top of its line into the $2 million to $2.5 million range with the C2-40, which has four vector-parallel processors. The system offers three to four times the power of a VAX 8700, with an architecture similar to Cray's X-MP 4-6, Vince says, but with hardware enhancements to make the system more fine-grained.

New parallel machines

Newer types of systems are generally first bought by government users, often the military, justifying development of a single large application, Dataquest's Willard says. Once a new architecture has been tested by research and university laboratories and catches on across the government marketplace, it moves out into the commercial sector. Some minisupers have made that transition, but a few of the new parallel architectures are still in the evaluation process.

"In the early '70s, the rage was for vector processors," Willard says. "Today, it is for highly parallel machines."

Scientific visualization is cited as the fastest-growing application area for minisupercomputers, including molecular engineering, oil-field modeling, structural/mechanical design, military systems, and scientific research.

One bright spot for some minisuper vendors has been the healthy expansion of overseas markets, particularly in Europe and Japan. Alliant set up a subsidiary in Japan, which grew from a five-person staff early last year to more than 110 today. More than half of the company's sales in the first quarter of 1989 were in Japan, according to Gruner, and he expects sales to split evenly among Japan, Europe, and the United States by 1992. Convex also has had good sales in Japan; this is probably because the Japanese computer companies seem intent on competing against IBM and Cray in the larger supercomputer sector rather than in the minisuper range, according to marketing vice president Vince.

European customers have been quicker to make decisions than many U.S. technical shops, Gruner says, perhaps because the companies there feel pressure to keep ahead of the tough competition in the United States and Japan. Considerable pent-up demand in the U.S. market will begin to break loose, he predicts, now that the earlier market confusion is being sorted out and DEC is getting its entry ready.

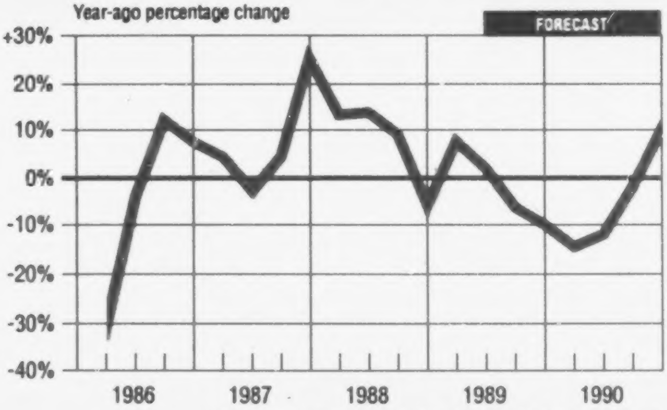
If so, the early rosy projections could come true after all, just a little later than expected. ☐

Leadtimes in detail

Average delivery times in weeks	2nd qtr. 1987	2nd qtr. 1988	2nd qtr. 1989	FORECAST 2nd qtr. 1990
Discrete semiconductors	6.6	7.8	7.9	7.4
Integrated circuits	6.7	7.5	8.3	7.5
Memory circuits	7.1	14.3	11.3	11.3
Microprocessors	7.4	9.1	8.4	9.4
Displays	7.6	7.9	9.9	6.6
Capacitors	6.6	6.9	7.5	5.6
Connectors	7.4	6.3	6.5	6.9
Printed circuit boards	6.4	5.8	6.5	5.3
Relays	8.0	8.2	8.8	8.2
Resistors	5.5	4.8	5.4	5.3
Switches	6.5	6.5	7.4	6.5
Wire and cable	4.6	3.8	4.2	4.6

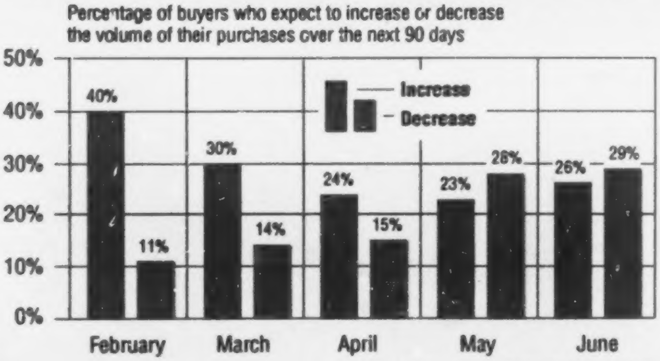
Data source: *Electronics Purchasing*, Forecast: Cahners Economics

Electronic component leadtimes



Data source: *Electronics Purchasing*, Forecast: Cahners Economics

Component buyers' expectations



Data source: *Electronics Purchasing*

Buyer survey hints at industry slowdown ahead

Delivery times for some key electronic components continued to shorten in the spring quarter of this year, according to *Electronics Purchasing* magazine's survey of buyers. Other component leadtimes, meanwhile, inched up from last spring's levels. This mixed performance in delivery times probably signals neither great growth nor a recession, but simply a flat period ahead.

Why no recession? Compare current leadtime performance with the last recession's performance. Four years ago, leadtimes fell below year-ago levels for seven consecutive quarters, toppling at a 48% year-ago rate in the autumn of 1985. Now, leadtimes for all components are forecast to fall for just five consecutive quarters, and may actually pop up once or twice during this period. The severity of the upcoming leadtime decline will be muted as well, with leads expected to drop at only a 14% rate in the early months of next year.

Buyers signal falling DRAM prices

Leadtimes for particular components also give some warning on the probable direction of future pricing. When delivery times get significantly faster, the ability of component manufacturers to raise prices is limited. If leadtimes fall fast enough, price declines may even be likely. When delivery times slow, the chances are that demand is greater than supply and price increases are more likely.

For example, take a look at what buyers are saying about the 1Mb DRAM availability and pricing situation. Delivery times for 1Mb DRAMs fell to 12 weeks in June, down from 23 weeks a year earlier. That 11-week decline in leadtimes has indeed been accompanied by falling DRAM prices. In a separate price survey, *Electronics Purchasing* magazine asks buyers what price they are actually paying for particular components. In the June 1989 survey, the typical buyer indicated 1Mb DRAM prices averaged $15.12, down from last year's $26.22.

Buyers are also telling us more directly that a slowdown is ahead. When asked what their purchasing plans are for components over the next 90 days, only 26% said they'd be increasing the volume of components bought in the latest June survey, down from 40% in the February survey. Meanwhile, the percentage expected to decrease their purchases has risen from 11% in February to 29% in June.

ELIZABETH B. BAATZ

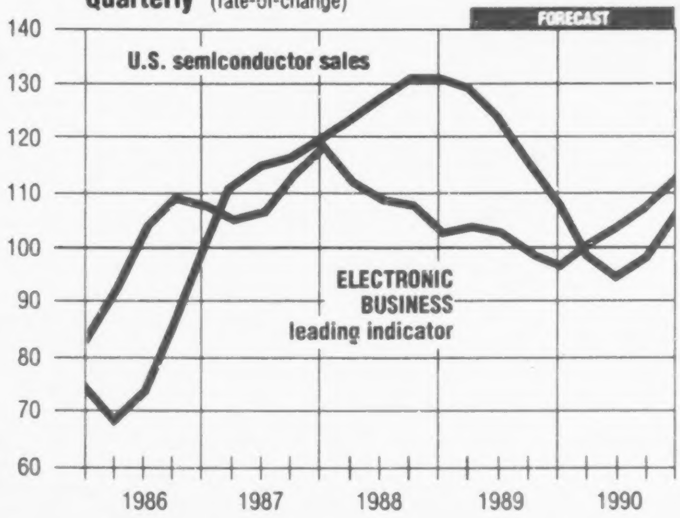
A column on leadtimes is scheduled to appear again in the November 13th issue

BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

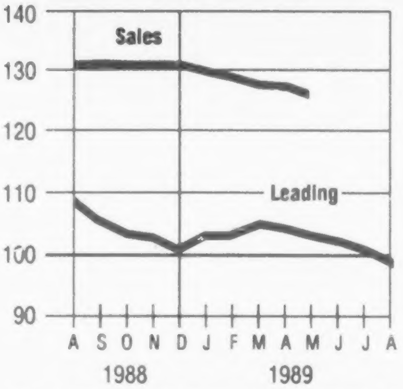
ELECTRONIC BUSINESS leading indicator

Quarterly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368

Monthly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator fell to 103.8 in April, down from 104.6 in March. The indicator has fallen 14% in the past year-and-a-half since peaking back in October 1987. This compares to the 44% collapse in the indicator during the year-and-a-half following the early 1984 peak. Clearly the indicator now says the 1989 downturn willl be much milder than the last electronics industry recession.

Source: Cahners Economics

Electronics industry indicators this month

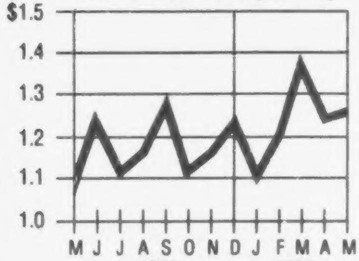
	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, April)	103.8	104.6	109.4	107.6
U.S. semiconductor bookings ($ millions, 3-month average, May)	$1,286	$1,358	$1,258	$1,178
Weekly hours of semiconductor production workers (monthly average, April)	40.2	39.5	39.3	40.2
Electronic components leadtime index (1977 = 100, June)	120.6	110.6	120.2	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, May)	55.9	51.3	58.2	54.4
Change in electronic components inventories ($ millions, SA, April)	+$11	+$10	+$18	+$80
Contracts and orders for plant and equipment ($ billions, SA, April)	$44.4	$42.7	$37.8	$39.4

SA = seasonally adjusted, all other data is not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

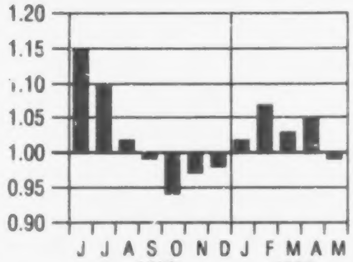
Semiconductor sales

Nortn American market ($ billions)



Source: Semiconductor Industry Association

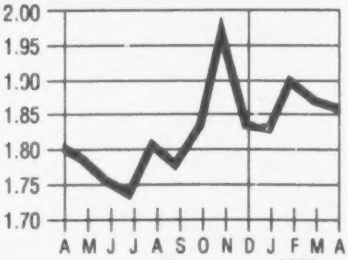
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted ratio



Source: U.S. Commerce Department

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

AUGUST 21, 1989

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Far East fuels ATE growth

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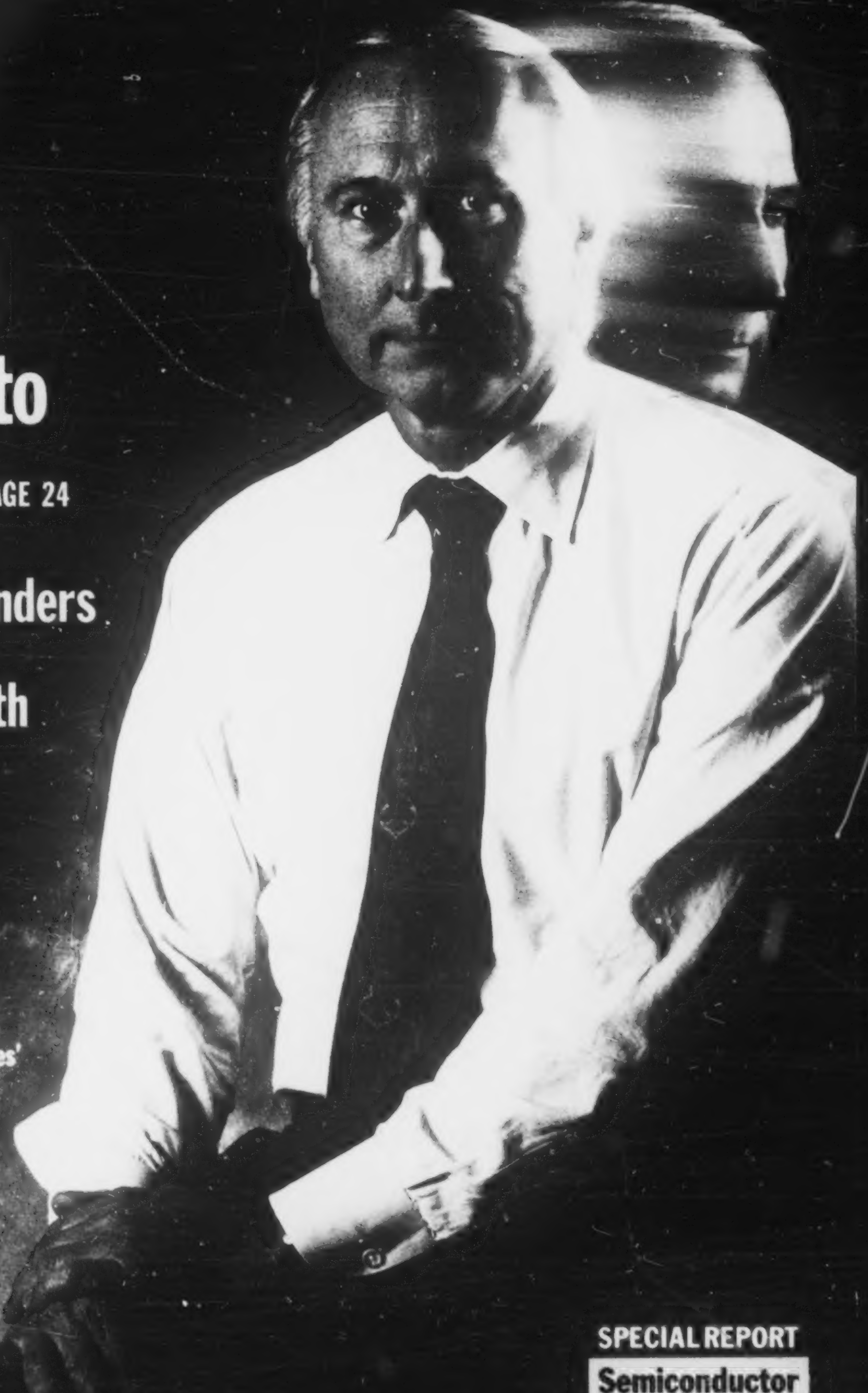

Ray Stata
Analog Devices'
chairman

SPECIAL REPORT

Semiconductor materials fears

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

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AUGUST 21, 1989

PAGE 24 Analog Devices' Ray Stata: "We expect some dramatic shifts in the company" to accommodate the focus on ASICs

COVER STORY/STRATEGIES

24 Looking long term: faces up to market swings

With the paring down of U.S. military programs, suppliers have been wise to seek new businesses for growth. At chip maker Analog Devices, chairman Ray Stata is staking some of his company's future on supplying ASICs to high-volume markets, such as computers and consumer electronics. But a move into uncharted territory can be sticky, so Stata is taking a methodical approach, not unlike the way a Japanese company would do it. Two first steps: upgrade manufacturing processes and learn to work more closely with customers.

BUSINESS TRENDS

17 Japanese drive makers set sights on 3.5-inch market

Despite a futile attempt to enter the U.S. hard disk drive market in the mid-1980s, the Japanese are being lured back by the promise of higher volumes in the 3.5-inch arena. Such grand ideas concern U.S. manufacturers, but the proposed acquisition of Imprimis by industry leader Seagate may temper the Japanese' move.

STRATEGIES

24 Looking long term: Stata faces up to market swings

By fiscal 1992, Analog Devices, the biggest analog IC supplier to the U.S. military, expects to generate just 10% of its overall sales from ASICs. And profits won't come right away either, the company says, because to stay ahead of the technology much of that money will be plowed back into development. But Analog Devices is willing to be patient. In switching the strategic focus to ASICs, "There's a big, big learning curve," says chairman Ray Stata.

SPECIAL REPORT

34 Silicon self-sufficiency: Why the U.S. needs a new plan

The United States has a startling overdependence on foreign sources for not only its IC production gear but also its raw polysilicon. Already, almost all of the silicon wafers used by the merchant U.S. semiconductor industry come from Japanese- and European-owned sources. While there's no shortage today, the loss of control over materials-supply lines may mean that the United States may not always be able to get wafers when it needs them. In a special report, ELECTRONIC BUSINESS explores the potential impact of a lack of silicon self-sufficiency and offers recommendations for action.

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41 **Nuclei for revival?**

MANAGING RESOURCES

48 Capital spending hits four-year high in 1988

Capital spending by the top U.S. electronics companies hit a four-year high in 1988, posting a healthy 28% growth over 1987, according to the ELECTRONIC BUSINESS annual listing of the top 100 capital spenders. But last year's performance is expected to be the peak of the cycle as market watchers are forecastsing a leveling off this year and next.

49 **Top 100 U.S. capital spenders**

EUROPE BUSINESS

57 SGS-Thomson hopes to bring life to Inmos' Transputer

As part of its continuing bid to become a top 10 semiconductor player worldwide, SGS-Thomson has taken the plunge into the combative 32-bit microprocessor market with Inmos Ltd.'s Transputer. The trick is to market the Transputer as more than just an also-ran.

Cover photograph: Dave Bradley

PAGE 36 Motorola's Hector Ruiz: "I believe we [as a nation] are being a little complacent about silicon"

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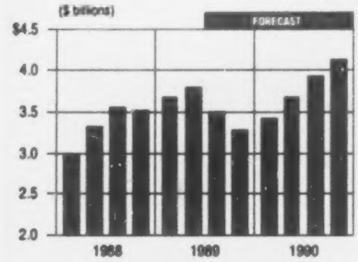

PAGE 82 Business Barometer: Will there be an industry-wide semiconductor recession?

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PAGE 11 Power Integrations' Ed Ross: Seeking a niche in the power IC market

ASIA PACIFIC BUSINESS

59 Taiwan is losing its luster as a haven for cheap labor

There is a new business climate in Taiwan. The country, changed forever by a weak U.S. dollar and increasingly expensive labor, is now moving away from assembly and toward production of higher value-added products. While some U.S. companies have moved out, others are staying put and automating.

MARKET PERSPECTIVES

62 Foot dragging in U.S. slows ATE market growth

1988 was a good year for the worldwide market for automatic test equipment. But that 21% growth was deceptive because it was selective both by type of ATE and by geography. And much of the growth — attributed principally to the memory chip tester arena — took place not in the mature U.S. market, but in the Far East. Signs are pointing to a flat 1989.

69 Fast-blooming CVD market: Equipment makers' bright spot

With hot new consumer applications fueling demand for complex chips, the market for chemical vapor deposition equipment grew 88% in 1988 over 1987, rising from $278.5 million to $523.2 million. Although currently dominated by a handful of U.S. companies, the consensus is that CVD will be a tempting target for the Japanese.

BUSINESS BAROMETER

82 Communication equipment

New orders for communication equipment fell in May, declining 3.2% from April to total just under $6 billion. The weakness was most evident in the defense portion of the industry.

83 Semiconductors

Sales of semiconductors to the United States continued to grow in the first half of 1989, but there's one question on everyone's mind: Will there be an industry-wide recession? The answer varies.

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Looking long term

When Ronald Reagan took over the U.S. presidency in 1981, the signal to defense contractors was clear: military spending on the whole would increase. But as the cliché goes, nothing lasts forever. And as the "Star Wars" president's first term evolved into his second, another message became increasingly clear: Congress, coming to grips with the ever-rising budget deficit, would begin to pare down defense programs.

For electronics suppliers to the U.S. military, such a slowdown in the growth of the market was cause enough to seek new business areas. Of course, you don't abandon your bread-and-butter markets just because growth has slowed. But, with a look toward the long term, some defense contractors are going after nontraditional niches for growth. Such is the strategy of Analog Devices Inc., the biggest supplier of analog ICs to the military.

Contributing editor Sarah Glazer writes our cover story, illustrating how Analog Devices is seeking new business growth from the unlikely areas of consumer electronics, computers and the automotive industry. Sarah is a longtime follower of electronics, having worked previously as a senior editor for *High Technology* magazine. She is a regular ELECTRONIC BUSINESS contributor and writes our Upstarts column.

At the heart of Analog Devices' strategic shift, Sarah writes, is a plan to supply ASICs to these hot, high-volume markets. Ray Stata, the company's cofounder and chairman, acknowledges that making such a transformation to ASICs is a tall order. Stata is going about his task in a methodical way — a continual chipping away until progress is made. And he readily acknowledges that such an approach is not unlike the way efficient Japanese companies do it. Sarah writes that a near-term goal of Analog Devices is to generate 10% of overall sales from ASICs by 1992.

Sarah Glazer, contributing editor

Silicon self-sufficiency

There's a startling over-dependence among U.S. chip makers on foreign sources for raw silicon. What is more, the chip makers don't seem to care, the U.S. government is indifferent and electronics trade groups are keeping quiet. The U.S. needs a new plan to become silicon self-sufficient, says editor-at-large John Kerr, in his special report in this issue. John argues that a fresh examination of the issue is warranted. He reports that there is cause for concern by the semiconductor industry and offers our recommendations for action.

MARVIN GREENE, section editor

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SPECIAL REPORT

Silicon self-sufficiency:

Why the U.S. needs a new plan

BY JOHN KERR

The U.S. has a startling overdependence on foreign sources not only for its IC production gear, but also for its raw silicon. The Japanese would not tolerate this situation — nor should U.S. chip makers

The apathy is astounding. If U.S. chip makers — they who care desperately about where U.S. computer firms buy DRAMs — care where their raw silicon comes from, they hide their concern well.

Indifference, it seems, loves company. Washington, the Defense Department included, is dead to the issue. The trade associations keep mum. No Sematech for this one, folks.

Such nonchalance may be a mistake.

Already, almost all of the silicon wafers used by the merchant U.S. semiconductor industry come from Japanese- and European-owned sources. More and more of the polysilicon — the silvery crystalline chunks that are the wafer makers' raw material — comes from Japan. And solid profits in poly and wafer businesses are as elusive as ever.

Texas Instruments Inc. is the latest U.S. chip maker to quit making its own "poly." Monsanto Co.'s sale this past April of its loss-ridden wafer operation to Huels AG of Germany was the most sensational retreat yet, slashing U.S. share of world wafer markets from 21% in 1988 to 3%. And Cincinnati Milacron Corp.'s wafer plant sell-off to Osaka Titanium Co. Ltd. is simply the latest example.

There's no crisis yet. Almost all the merchant wafers used by U.S. chip makers come from U.S. plants, albeit mostly foreign-owned. But should the U.S. continue to make apathy a virtue, control of the materials-supply lines crucial to its merchant IC production base may be out of its hands a decade from now.

Price, availability and technology are the soft parts. Unlike 1989, when American chip makers can all but name their price, 1999 could put them on the pointy end of a sellers' market. While there's no shortage today, the United States may not always be able to get wafers when it needs them. And sorriest of all, it may, as it pushes submicron feature sizes, have to be grateful to get wafers that are less than state of the art.

A problem? You bet. Even though such major players as AT&T, IBM and TI retain solid research and wafer-production activities in-house, there's concern for the industry as a whole — particularly as it relates to tomorrow's technology edge. "The question is whether we can count on getting the latest and greatest [wafer technology]," remarks Robert Noyce, Intel Corp. vice chairman and currently CEO of Sematech, the government-backed United States chip makers' consortium. Warns one United States Commerce Department analyst: "I don't know how an IC device industry can think of being viable in future if it doesn't know who'll be supplying its silicon."

Shades of the oil crisis and the DRAM debacle all over again? Could be.

The problem is neither new nor isolated. It's not a problem of lost jobs; it's mainly about technology transfer, and it is as politically charged as it is technically complex. In fact, the problem of silicon sourcing is only a fraction of the issue at large — the issue of America's self-sufficiency in semiconductors.

It's a problem that forces fresh examination of government's attitude toward technology and one that highlights weaknesses in the relationship between the average chip maker and the average silicon supplier. It transcends the value of the myriad alliances between U.S. and non-U.S. companies. It also illuminates the flaws in a federal tax structure that scarcely encourages long-term investment.

U.S. IC makers already are heavily reliant on Japan for production gear; process chemicals; the masks used to help print the circuit designs; and much else. But silicon's centrality to all phases of IC fabrication and its evergreen influence on everything from manufacturing costs to circuit density make it a pivotal discussion point — and the heart of an issue worth fighting for.

What follows is an attempt at consciousness-raising, an appeal for integrated thinking to acknowledge the dangers in taking too much technological candy from strangers. In this special report, ELECTRONIC BUSINESS explores the potential impact of a lack of silicon self-sufficiency and offers recommendations for action. The actions, we believe, the industry should take before it's too late. ☐

Kevin Hawkes

Defining the problem

Ah, the cute little microchip! How clever and quick you are! How famous and proud you've become! So proud, in fact, that you seem to have forgotten the quaint materials that made you possible in the first place.

Don't. They still control your future.

"The lack of R&D and lack of participation [in silicon materials by U.S. companies] may exclude the U.S. from new business that will depend on silicon in ways we can't put a finger on right now," warns William O'Mara, a vice president with Los Altos, California-based electronic-materials consultancy Rose Associates.

Meaning: Japan in particular is edging ahead in the basic materials science that could yield entirely new generations of ICs.

Its nondefense R&D spending accounts for 2.8% of GNP, compared with the U.S. level of 1.8%. While specific figures on materials research are not easily available, anecdotal evidence of Japan's edge abounds.

Also, Japan's chip makers are, by all accounts, tighter with their silicon suppliers than their U.S. rivals — with real payoffs. Sources maintain that Toshiba Corp. owes its high yields and strong productivity in one-megabit DRAMs to its direct funding of its wafer-making Toshiba Ceramics subsidiary, and to an intimate sharing of IC performance and process goals with poly suppliers such as Komatsu Electronics Inc.

Consider the following hypothetical scenario:

The world's largest silicon wafer maker, a Japanese firm, decides it wants more control of the world's polysilicon supply and boosts to a controlling interest its current 24.5% stake in the major United States poly supplier. The poly firm's parent, currently a majority shareholder with 63.25%, is only too happy to oblige to appease stockholders concerned with the poly unit's meager profits.

The Japanese player, suddenly with more than 15% of world polysilicon capacity, feels it has the economies of scale and the deep pockets to pull pricing initiatives. It begins offering poly at $35 per kilogram — the norm is over $40 today — and a year later, its market share gain is noticeable.

A giant U.S. chemicals conglomerate, still struggling to have the poly from its new $100 million-plus plant qualified with more customers, feels the heat as shareholders lose patience. Already in litigation with Japanese rivals over alleged dumping, it ups the tempo in the courts — loses in them — and mothballs the facility.

Japan's share of world capacity — to cut world overcapacity, no Japanese company buys the silent U.S. plant — rockets from the current 30% (treble its share in 1979) to 60%, with its chief rival —a West German company — grimly hanging on to most of the rest.

Building on its manufacturing and R&D strengths, and on its stronger control over raw poly, the Japanese player begins offering U.S. customers cleaner, flatter wafers, using this as a lever to pump prices much as Japanese automakers blunted trade quotas by adding value. The across-the-board increases push some marginal U.S. chip makers over the edge; other larger IC firms, unable to pass along the added cost to computer customers, lose share.

Problems: A - Z

The U.S. silicon supply base is in trouble because:

- There's no widespread awareness, acknowledgement or understanding of the problem
- There's less commitment to long-term materials research than elsewhere
- There's a harmful urge toward "commodity buying" of wafers
- U.S. wafer suppliers are lucky to make 3% net income in good times and usually lose over 5% on sales in bad times
- U.S. cost of capital is high and capital investment focus is too short

Our Tokyo-based dynamo is now making enough profit overseas to be able to relax prices domestically, enhancing the competitiveness of Japanese chip makers. Those customers also win the first allocations of wafers, forcing U.S. customers to the back of the queue and into leadtimes of eight months.

Japan's payoff

Years pass. Japanese silicon suppliers begin to earn the payoff from a decade of intensive R&D spending on surface contamination and defect analysis. Their wafers produce economies of scale — 8-inch and larger wafers that are flat and clean enough to produce high yields in mass production — and the flawlessness necessary to get down to 0.2-micron linewidths with ease. Favored Japanese chip makers get samples six months ahead of U.S. and European customers, and are first to market with the one-inch square half-gigahertz microprocessors and the microscopic 256-megabit DRAMs that the gigantic pocket-computer industry of the late 1990s is waiting for.

End of story. Sounds alarming to U.S. ears? Certainly. Is it plausible? In essence, yes.

There are many worrisome precedents. Foreign auto makers' inroads are a classic example; for instances closer to home, look at Japan's rise to dominance in IC packaging materials, and the infamous DRAM skirmishes. (Comparisons with the DRAM problem require care: although tight interrelationships exist, the silicon business does not enjoy the same degree of vertical integration that Japan's chip-through-computer sectors do. Also, the foreign silicon firms maintain considerable United States manufacturing operations.)

This is not to say it will happen — only that it *could* happen. There's plenty to conspire against it: U.S. government trade blocks; combined action by U.S. chip makers, broader global technology liaisons; the rise of a new U.S. technology; emergence of different chip-production techniques. Some, such as Intel Corp.'s manager of fab materials, Fred Voltmer, see safety in continued imports: "As long as foreign silicon firms export to the U.S., we'll get the technology."

Others like to know that many of the foreign-owned wafers they buy come from the U.S. factories of Japanese world wafer leader Shin-Etsu Handotai Co. Ltd., West Germany's Huels AG and others. "That makes me feel a little better," says Stephen Cooper, president of Beaverton, Ore., IC maker Bipolar Integrated Technology Inc.

Cold comfort

There's comfort for many in knowing that IC technology leaders such as IBM and AT&T keep wafer production in-house. Altogether, notes Rose Associates, U.S. captive wafer production, at around 70 million square inches a year now, comprises about 15% of total U.S. needs.

And there's a train of thought among U.S. chip makers that says it doesn't matter who makes the wafer substrates because of the growing popularity in the merchant market of "epi" — the epitaxial wafers whose bare substrates are coated with a vapor-deposited layer of pure silicon. Epi can be brought in-house for a capital cost of about $1.8 million; including operating costs, an IC maker — provided it has the output to justify the investment — can control its own wafer surface make-up for under $800,000 yearly.

> **"From a half-micron linewidth and beyond, silicon material purity is becoming critical"**
>
> **A senior IBM technologist**

Complacent

But others with a mandate to look further than next month's supply show more unease. Says Hector Ruiz, director of technology for Motorola Inc.'s semiconductor operations: "I believe we [as a nation] are being a little complacent about silicon. The level of concern should be heightened." Adds another industry executive: "I think it's scary."

The components of the problem are several, and perhaps the most immediate is that voiced by Ruiz: there's no real base of concern, and little understanding of the problem.

As a natural consequence, it's no surprise that materials research is not on the IC industry's front burner. Nor is it astonishing that IC makers hurt their wafer suppliers more than they help them by nickel-and-diming them to death. Chip makers' buyers, motivated to get the best possible price, insist that quality is purchase parameter No. 1, but continue to treat wafers as commodities. "IC makers are doing the same thing with their suppliers that they've accused their customers of doing," argues a senior Commerce Department analyst.

Pitiful profitability

The pricing issue is key to another aspect of the problem: the pitiful profitability of wafer makers. By one senior Intel executive's estimate, wafer suppliers are hard-pressed to make 3% to 4% net income on sales

Why no one seems to worry

U.S. politicians have this giddy belief that because silicon is made from the same stuff as sand, Saudi Arabia ought to have a lock on the chip business.

Just goes to show: you can take a pol to wafer, but you can't make him think.

Political naiveté about the intricacies of the issue is only one reason why no one is up in arms about silicon self-sufficiency. Nor is it perceived to be a "national security" hazard — meaning that the Defense Department can still locally source the semiconductors it needs for its most advanced technology.

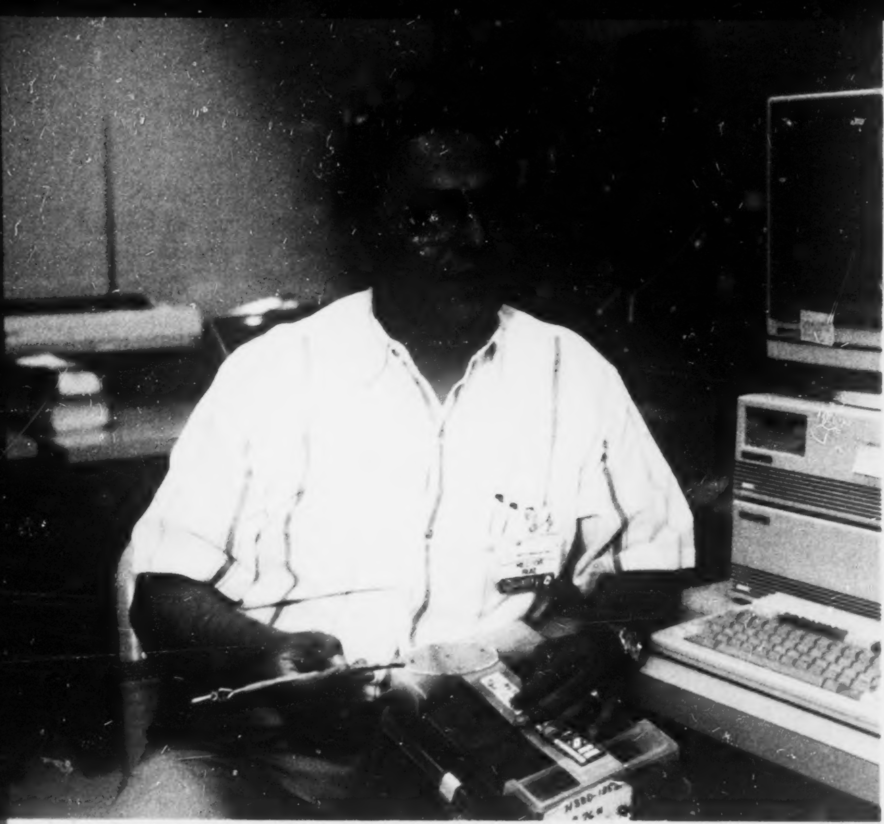
Hence a government that only smiled politely when Samuel Harrell, president of Semi/Sematech, a group of United States equipment and materials vendors formed to work with Sematech, took issue with the federal interagency group whose conclusions led President George Bush to permit the Monsanto sale earlier this year.

Washington now understands something as feted as the chip; that, spiced with some particularly vociferous lobbying, quickly gave America's DRAM deficit star billing. More moaning to Washington made the pols understand that something had to be done about U.S. chip-making prowess — hence Sematech.

And the lawmakers' ready appreciation for the power of the "tube," plus the American Electronics Association's shrill campaign, mean enthusiasm galore for high-definition TV.

But there's no such furor over America's silicon overhang. It's easy to see why:

- **First, materials are to ICs what sawmill rough cuts are to Chippendale chairs: decidedly unlovely.**
- **Second: If you think your congressman has trouble figuring out what software is, imagine how he or she will cope with superlattice structures.**
- **Third: The IC production process is today's principal bottleneck, not the materials technology.**
- **Fourth: Most U.S. chip makers, getting adequate quantities of high-quality wafers on time and at good prices, are happily and legitimately wed to foreign suppliers (at least for their own offshore plants' needs) and have no intentions of rocking any boats.**
- **Fifth: The considered view is that the real value-added in an IC is in the circuitry. Uncoated substrates — polished wafers — account for only about 5% of the manufacturing cost of a typical IC device.**
- **There is a sixth reason for silence over silicon: the federal government has enough on its plate as it tries to prioritize its myriad high-tech trade worries. And Uncle Sam is too committed to the free-trade ethos to worry unduly about strategic sourcing.** ☐



Hector Ruiz, Motorola's director of technology: Worried by the potential impact of Japan's apparent lead in materials technology

in good times, and when times are bad, they'll usually drop to 5% net losses. "You've got to have more upside than downside," he says. There's no history of that.

St. Louis-headquartered Monsanto Co.'s case is not unusual. From 1983 until the sale this April to Huels, its wafer-making unit lost an aggregate of about $270 million on sales that in any one year never topped $185 million. Monsanto declares a corporate goal of 20% return on equity.

But Japan's wafer makers, headed by world market share leader Shin-Etsu which had estimated 1988 sales of over $450 million, are, according to Rose Associates, riding to profit on the back of the higher-margin six-inch wafers that were demanded by last year's DRAM boom. Next stop: wafers for the imminent wave in 4Mb DRAMs.

Explains a recent issue of Rose Associates' *Electronic Materials Report*: "150mm wafers for 4Mb DRAMs are viewed as the growth and profitability segment of the industry. Those that can optimize their yields to these stringent specifications at an early date will be able to drop profits to the bottom line. But the window of opportunity here will close rapidly as many of Japan's 10 wafer makers get quickly up the learning curve, and competitive pricing once again begins to erode profits."

The story's no different for U.S. makers of the polysilicon. They face a world market where the production plants currently can churn out 60% more of the silver-gray stuff than anyone needs.

Compounding the financial problem is America's low tolerance for poor short-term returns, and its exorbitant cost of capital. A recent white paper from the American Electronics Association entitled: "America's Future At Stake: Winning in the Global Marketplace," claims that a U.S. company acting rationally can forsake $1 of current earnings for $1.20 in future earnings only if the payoff comes in less than three years — a quarter of the time span that its Japanese equivalent can endure.

Says Sematech CEO Robert Noyce: "I see [the weakening of the U.S.-owned silicon supply base] as a symptom of a fundamental sickness; America is not savings-driven enough. The main issue is that America, because of its shortage of investment capital, is going to have continuing problems like this."

You said it, Bob. ☐

Is it the same story in GaAs?

By 1991, the joke goes, suppliers of gallium-arsenide (GaAs) IC wafers will be offering their products for free. A year later, they'll be shipping a $100 bill in every box of wafers.

The joke refers to the steep slide in the price of the three-inch wafers that make up the mainstream production of such GaAs chip makers as GigaBit Logic Inc. and Triquint Semiconductor Inc. Costing about $900 in 1982, the wafers are now tagged at around $165 and under $150 in large volume.

With yields on GaAs semi-insulating wafers climbing rapidly and substantial overcapacity in place, that price can be expected to keep sliding sharply. As with the silicon business, wafer makers reap little or no profit, and deep-dive prices won't help.

An inescapable consequence is attrition among wafer suppliers; sources that track the GaAs supply predict that only about 18 firms will be active by 1994, compared with about 25 today. That, of course, will be welcome to the survivors: Says Dr. Russell Kremer, staff scientist at Colorado Springs-based GaAs wafer firm Crystal Specialties International, a foreign-owned firm which intends to be among that number: "About the only way you can make money is to increase market share."

That, coupled with a growing obsession with repeatable quality, favors the players with the deep pockets — like top-ranked Sumitomo, which has about 15% of the world's GaAs wafer markets. The jury is still out — observers say it's still up for grabs which country dominates the GaAs materials market. In 1988, the U.S. has 47% of semi-insulating GaAs wafer production against Japan's 32% and Europe's 20% of a $21 million market worldwide; the United States, consuming 60% of world output, is a net importer.

But there are telling pointers of future market dynamics. Says Crystal Specialties' Kremer: "Some very nice work is being done by Japan in GaAs in consumer electronics." ☐

Waiting out a poly plethora

To say that polysilicon is a buyers' market is to point out that the Pope is Catholic. Worldwide, there is about 60% more poly production capacity than consumption.

It could be worse. According to one market researcher, the PC madness of the mid-'80s produced dollar-crazed plans for 23,000 metric tons (tonnes) of poly capacity by 1990 — over twice current potential.

Today, global poly capacity is put at around 10,800 tonnes yearly —under 5% of it for photovoltaic uses — by consultancy Rose Associates, with usage at about 6,800 tonnes. Poly makers don't see signs of the two balancing out before 1995.

The overcapacity issue is one that hurts U.S. suppliers and favors those with the longer view and deeper commitment. Significantly, Japan's portion of worldwide capacity has ballooned: from just over 10% a decade ago to nearly 30% today, with Rose Associates projections figuring almost 40% by 1991, assuming that all the players stay in the game and under their present owners.

The folks who invest in poly plants are made of the same stuff as Peace Corps volunteers. You'd need to be optimistic, and deep-pocketed too, to live with no return for year after year, and with no relief in sight.

With overcapacity as it is, there's little prospect of availability or pricing problems for poly customers well into the 1990s. James McCormick, president of major U.S. producer Hemlock Semiconductor Corp. in Hemlock, Mich., has adapted the Boston Consulting Group experience curve to plot accumulated tonnage against price per kg., and it's a steady slide to the right.

Wafer makers know it — and as beaten over the heads on price as they are, they expect it. Consequently, price per kg. has eroded from $70 to $80 15 years ago to just over half that now. Prices of $42 in small quantities are not uncommon.

Compounding the issue is the higher utilization of wafers — higher yields than ever mean slower demand growth.

It's tough for poly makers. Some, like Japanese steel giant NKK Corp., bought older U.S. plants and laid out grand plans for new plants on U.S. soil before shelving everything. Texas Instruments Inc. and Motorola Inc. recently shut down their own poly operations. And Union Carbide Corp., although it set a 1,200-tonne facility going a few years back, is locked in lawsuits charging that seven Japanese suppliers created a price-cutting cartel.

Although the poly processors play their financials very close to the vest, few observers believe that they're profitable. With little hope of reasonable price increases until overcapacity is mopped up, the only escape route is through beating down process costs. And there are limits to that: because poly is made by building up crystal deposits on an electrode, its production has a ferocious appetite for electricity.

Present production costs per kilogram of poly run about $20; depending on speed of deposition, local electricity costs and a few other factors some poly makers could see electrical power accounting for well over two-thirds of their process costs.

"Everybody hopes for better times. Staying below the [price-cumulative volume] curve is really our driving force," sighs Hemlock's McCormick.

High hopes

One newer U.S. player — Richmond, Virginia-headquartered chemicals giant Ethyl Corp. — has hopes of staying way below the curve, aiming for a return on investment of over 15%. Relying on a new process that produces polysilicon pellets with more efficiency than the conventional techniques, Ethyl has, in six years, moved from pilot plant to full-blown 1,250-tonne-per-year facility — an investment of just under $45 million whose capacity can be doubled for an extra $20 million.

Things aren't going quite as smoothly as Ethyl had hoped, though: "Our market penetration has been slower than we would have liked, primarily because of long qualification times and market overcapacity," says Fred Anderson, marketing manager for silicon materials at Ethyl's electronic materials division. He also cites a practice he claims has been gaining ground in the past two years: the ability of IC makers to veto their wafer suppliers' poly sources.

The old Monsanto wafer facility — now owned by German giant Huels — is Ethyl's only volume customer; others are sampling and qualifying. Consequently, the Louisiana plant is

More polysilicon than anyone wants

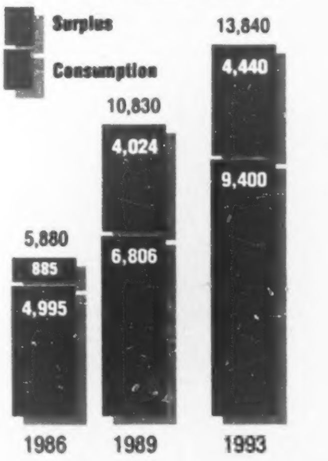
Shifting capacity shares

Polysilicon capacity (metric tons)

U.S.	**1984**	**1988**
Hemlock	1,300	1,500
Union Carbide	100	1,200
Ethyl	0	1,250
Texas Instruments	250	0
Monsanto	230	0
Motorola	50	0
Great Western	200	0
Total U.S.	**2,130**	**3,950**
Japan		
Tokuyama Soda	200	1,200
High Purity	800	1,100
Osaka Titanium	360	600
Shin-Etsu Handotai	150	150
Komatsu	70	70
Total Japan	**1,580**	**3,120**
Europe		
Wacker	2,400	3,000
Huels (DNS)	350	400
Total Europe	**2,750**	**3,400**
Total world	**6,460**	**10,470**

Consumption vs. capacity

Worldwide merchant and captive polysilicon capacity (metric tons)



Source: Rose Associates

running at half-capacity, with Anderson's aim being two-thirds capacity by year-end.

The lessons from the poly business are several. First, today's overcapacity won't last forever, and could quite quickly turn to shortage unless the poly crowd has the full forecasting cooperation of its customers, and its customers' customers.

How? Because IC demand, higher utilizations aside, climbs relentlessly, and because it takes about two years to build and bring a new poly plant on stream. Don't expect the producers of the pewter-colored chunks to say "How high?" when chip makers tell them to jump next time; the mid-1980s mania has cured them of that.

Second: this is a high fixed-cost business: Ethyl's $45 million outlay seems to be the minimum, and plants of around 1,000 tonnes capacity are about the optimum. The people with best access to low-cost capital live in — you guessed it — Japan. □

Wafer firms feel the squeeze

U.S. chip makers don't know their own purchasing strength. "They've got enough clout to squeeze their wafer suppliers," says Richard Winegarner, CEO of Sage Concepts Inc., a research firm that tracks silicon supply dynamics.

And squeeze they do. "We're asking them to do more for less," says Paul Luvisi, Hewlett-Packard Co.'s corporate procurement manager for chemicals and materials, of his wafer suppliers.

Confirms Michael Christ, president of one small U.S. wafer maker, Recticon Corp.: "We've seen customers decide on the basis of a few cents' difference."

IC makers, of course, would have you believe that they buy primarily on quality. While clearly true, this does not excuse their fixation with price when it may come at the expense of their supplier base. "The IC purchasing guy is successful on a micro scale, but on a macro scale, he's killing the [U.S. wafer] industry," explains Sage Concepts' Winegarner.

Although supply and demand worldwide are roughly in balance — worldwide wafer consumption (merchant plus captive) this year is 1,621 million square inches, according to Rose Associates — there's little let-up in prices.

Today, the 4-inch polished wafers that are the mainstream are priced at under $10 in volume, with epi wafers about treble that. Six-inch polished wafers cost over $20. U.S. IC makers appear to be expecting a 15% to 20% drop in polished-wafer prices over the next two years, and for at least the same in epi.

The complaints from the wafer side are predictable. "This industry is still underpriced in regard to its cost of manufacturing," says Recticon's Christ.

About the only time it wasn't so was in the year that PCs were everybody's darling: 1984. Prices rocketed as leadtimes stretched from today's comfortable eight weeks for polished substrates to 42 weeks.

Today, the only complaints of availability surround epi, where delivery is taking up to 25 weeks, in the case of one customer.

Can 1984 happen again? It's unlikely. Price and availability of silicon wafers will remain fairly stable for the foreseeable future, especially with Europe acting as the counterbalance to Japan's wafer weight.

German challengers

West Germany's two silicon titans — Huels and Wacker Chemis GmbH — are formidable challengers. Now that Huels owns Monsanto's facilities, the Teutonic pair has cornered nearly 35% of the world wafer market this year against Japan's 62%. Huels, a relative newcomer to the business, now goes head-to-head with Shin-Etsu for market leadership.

Huels, Wacker, Shin-Etsu and many of the other foreign players have production in the United States; as part of its purchase, Huels has committed not only to expand American production but to maintain a strong R&D effort in the States. "We're a stronger company than under Monsanto," vows Roger McDaniel, CEO of the new U.S. operation, called MEMC Electronic Materials Inc.

Huels also indicates willingness to support Sematech, a prospect that makes some U.S. observers shudder as they monitor Europe's aggressive efforts in semiconductors. "You can see the technology leakage path there already," warns a top Commerce Department official. □

How world wafer-making has changed hands

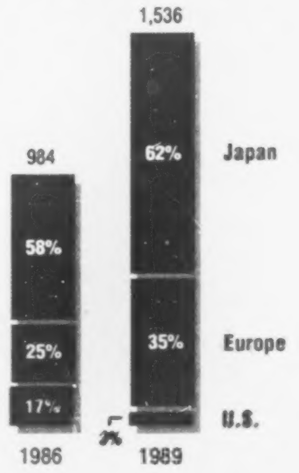
Players, then and now

Merchant wafer production
(millions of square inches)

Japan	**1986**	**1989**
Shin-Etsu Handotai	270	345
Jasil/Siltec	96	190
Osaka Titanium	100	160
Komatsu	58	115
Others	50	135
Total Japan	**574**	**945**
Europe		
Wacker	195	220
Huels (DNS)	46	310
Others	6	10
Total Europe	**247**	**540**
U.S.		
Monsanto	125	—
Cincinnati Milacron	8	—
Others	30	51
Total U.S.	**163**	**51**
Total world	**984**	**1,536**

Merchant market shares

Merchant wafer production
(millions of square inches)



Source: Rose Associates

May the cleanest wafer win

The elder statesmen of the IC business remember well: the days and nights spent tinkering with weird materials to cook up just the right semiconducting properties. "This industry was driven by materials from the start," says Fred Voltmer, Intel Corp.'s manager of fab materials.

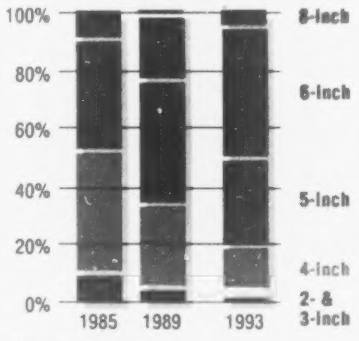
Not so now: the emphasis, as any EE college kid will tell you, is on design. But that may soon have to change.

Present-day chips and their production economics are constrained chiefly by process, not by raw material chemistry. But the newer devices are starting to impose tougher demands, right down to the poly level. "We do know that polysilicon does influence the performance of our devices. Defects in the bulk material have to be more and more controlled," according to Intel's Voltmer.

There are plenty who say that Japan is well ahead of those demands. Says a senior staffer at a prominent electronic-materials laboratory: "The irony is that the Japanese take out impurities *before* it's important because they expect it will become important. I think that some differences [in bulk materials chemistry] will show up in the next five years that will screen out some silicon versus other silicon."

Big wafers are coming and they have to be clean

Worldwide wafer mix (Percentage of square inches of wafer surface, merchant and captive)



Source: Dataquest Inc.

In other words, a new, purer standard is coming. Those that anticipate and meet it get the business.

United States poly suppliers such as Hemlock Semiconductor Corp. — a joint venture between Dow Corning Corp., Japan's Shin-Etsu and a unit of Mitsubishi Metal Corp. — and chemicals giant Ethyl Corp. are proud of the immaculacy of their materials. "We reached semiconductor-grade very quickly," boasts Fred Anderson, marketing manager for silicon materials at Ethyl's electronic materials division. He boasts of phosphorus content down to one-tenth of a part per billion (atomic), and only two-tenths parts per million for carbon. Heavy-metal (chromium, iron, etc.) levels —another critical determinant of performance —have been whittled from 15 ppb to 5 ppb in the last few years, with promise of dropping lower still.

Not good enough, say those in the forefront of IC technology. As manufacturers bring up volume processes for making devices with tighter and tighter linewidths, purity (repeatable purity) must push down into the parts per trillion — the limits of the equipment being used today to measure that purity. "From a half-micron [linewidth] and beyond, it's becoming critical," says a senior IBM technologist.

Critical at least for satisfactory manufacturing yield; when it comes to the performance of the device itself, parts-per-trillion cleanliness may be demanded for the 0.1- or 0.2-micron linewidths that may be in volume production 15 years ahead.

Why precisely will it matter? Because unwanted impurities such as carbon and oxygen and heavy metals, and point defects such as vacancies in the atomic lattice, lead to fundamental performance flaws such as electrical charge leakage and reduced lifetime. They also foul up some IC manufacturing steps such as diffusion and ion implantation.

Sagging wafers

Another killer: impurities and defects govern the mechanical strength of the wafer. That matters with the larger 8-inch wafers that will appear

Nuclei for revival?

All is not lost. Here are a few building blocks for a revival of U.S.-owned capability in silicon:

- **Under wraps: A voluntary initiative by an independent U.S. group believed to be exploring the mutual goal of less reliance on foreign-owned silicon sources. Believed to comprise at least one U.S. chip maker; a U.S. polysilicon supplier; and a U.S. wafer maker.**
- **Wafer production is still in place at IC units of, among others: Texas Instruments Inc.; IBM; AT&T; and Motorola Inc.**
- **The existence of the National Advisory Committee on Semiconductors, a top-level body formed under Omnibus Trade and Competitiveness Act to report to Congress to help formulate national policy.**

It includes such industry luminaries as TI chief Jerry Junkins, Applied Materials Inc.'s Jim Morgan, National Semiconductor Corp.'s Charlie Sporck; and has a technology subcommittee. It is expected to finalize recommendations next month.

- **The Sematech effort to modify U.S. legislation under the Trade Act to determine and accommodate the strategic nature of materials sourcing.**
- **Expertise in materials in laboratories such as: Bell Labs; David Sarnoff Research Center; University of Illinois; UCLA; Stanford; MIT; and in materials analysis at analytical labs like Charles Evans & Associates;**
- **Expertise in materials in IC firms such as: Texas Instruments; Motorola; AT&T; Intel; IBM;**
- **Expertise in silicon-making infrastructure: crystal-pulling machinery from firms like Kayex (a General Signal Corp. unit); wafer polishing pads from firms such as Rodel Products Corp.**
- **Sematech's effort in materials research.**

in volume in the mid-1990s: they're big enough and thin enough to sag under their own weight, which wreaks havoc with the focus when trying to imprint pin-sharp circuit patterns all over the wafer's surface.

The machining of wafers from ingot is equally critical: wafer flatness and surface roughness take on new importance as circuit densities increase and 6- and 8-inch wafers come on stream. The micro-roughness to some extent governs the quality of epitaxial layers grown on the substrates: the flatness governs the sharpness of the circuit images repeatedly printed across a wafer.

Other phenomena are barely understood, but may prove critical in the next decade. Recent Japanese research indicates that no matter how clean you get a wafer, it will still "remember," through a puzzling chemical characteristic, its original condition and revert to that.

Familiarity with surface chemistry will become mandatory too: as IC device sizes shrink, surface-to-volume ratios change, forcing IC performance and manufacturing cost-efficiency to rely more on surface makeup.

> **"IC makers are doing the same thing with their suppliers that they've accused their customers of doing"**
>
> **Senior U.S. Commerce Department analyst**

That wafer cleanliness is more important than ever is reflected in the U.S. start-ups that have obtained funding to develop cleaning equipment for use in wafer fabs. Examples include: CFM Technologies Inc. of Lionville, Pa., and Advantage Production Technology Inc. of Sunnyvale, Calif.

U.S. start-up activity aside, consensus points to Japan's occupation of the R&D high ground. Says Intel's Fred Voltmer: "The Japanese are spending a tremendous amount on surface chemistry [at a rate that] is not being replicated in the U.S." Japan is also pushing the frontiers of metrology, on the premise that if you can't measure a flaw, you can't make it go away.

That's a position which, as more and more control of the basic silicon markets heads east, can only be strengthened. Laments one U.S. silicon scientist: "We just don't have the inner drive to make things cleaner and reduce variability, and the Japanese do. U.S. firms just don't want to know." ☐

Action items: Where to from here?

Accepting that U.S. chip makers are over-reliant on foreign sources for their silicon, what should be done? Here are a few guidelines:

Who should act	What they should do
Sematech board members	Bolster Sematech's basic materials research — particularly bulk silicon purity and consistency, wafer surface contamination, defects, measurement methods and wafer-cleaning techniques.
IC, wafer and polysilicon executives	Promote much closer working relationships — employee exchanges, sharing of more IC design data — between chip makers and their silicon suppliers.
All IC- and related-industry executives	Champion formation of multi-industry consortium or joint venture to research advanced silicon materials and processes. Venture to include molten-materials processors, (steel or chemical companies), crystal pullers (silicon wafer makers), IC makers, IC equipment and chemicals makers and selected IC users.
All IC- and related-industry executives	Champion formation of a similar venture to produce advanced materials, preferably without government funding. Joint DRAM venture — U.S. Memories — is a prospective model.
IC executives	IC makers should consider buying equity in wafer, poly suppliers.
IC CEOs, CFOs	Explore mechanisms for floating intra-industry low-interest funding to support future silicon production.
AEA, SIA, EIA, CBEMA	Back proposed legislation to increase funding for a silicon-materials study by the National Institute for Standards and Technology.
Procurement managers at IC makers	Foster organizational mechanisms for reducing "commodity buy" tendencies in IC firms' purchasing departments. Encourage IC makers to ease wafer cost targets; strike longer contracts for higher quality and guaranteed delivery; reward buyers on wafer quality beyond spec.
Managers of U.S.-owned IC operations overseas	Foster mechanisms for technology feedback from abroad. Encourage U.S.-owned offshore IC plants to partner more tightly with foreign silicon suppliers.
IC wafer-facility managers	Encourage existing IC makers that make wafers to consider supplying merchant markets
R&D directors at IC makers	Concentrate more R&D expertise on alternative high-performance IC structures, such as silicon-on-insulator wafers.

Capital spending hits four-year high in 1988

But don't look for more big gains by the ELECTRONIC BUSINESS top 100 capital spenders in 1989. A "be cautious" leveling off is expected

BY BRUCE C.P. RAYNER and LINDA STALLMANN

Capital spending by the top U.S. electronics companies hit a four-year high in 1988, posting a healthy 28% growth over 1987. But last year's good performance is expected to be the peak of the cycle as market watchers are forecasting a leveling off in capital spending this year and next as a result of fallout from higher interest rates and a slowing economy.

Total capital spending by the top 100 publicly held U.S. electronics companies in an exclusive ELECTRONIC BUSINESS survey rose from $18.3 billion in 1988, up from $14.3 billion in 1987. But while this represents a healthy commitment to expansion, the industry nonetheless remains cautious about expanding capacity too fast after the boom/bust experience of four years ago. In nominal terms, the 1988 figure is still below the peak of $20.8 billion reached in the boom year of 1984.

Topping the ELECTRONIC BUSINESS list of capital spenders last year was none other than IBM, with a total of $5.39 billion, up 25% from 1987. IBM accounts for 29% of the total spending by the top 100 companies. Indeed, most of the industry's capital spending is done by the biggest companies: the top 10 companies on the list spent 68.5% of the total. To qualify for inclusion on the list, a company must be a publicly held U.S. company, derive at least 70% of its sales from electronics and be listed on the ELECTRONIC BUSINESS 200 ranking [ELECTRONIC BUSINESS, July 24, 1989].

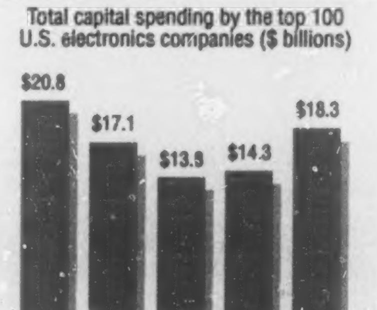
But while IBM spent the most, it was DRAM-maker Micron Technology Inc.'s spending that grew fastest. It outstripped all the rest by increasing capital spending a whopping 877.6% to $44.3 million as it capitalized on the DRAM shortage. The company reportedly will boost spending by 376% in 1989, according to semiconductor analyst Jonathan Joseph, Montgomery Securities, in San Francisco.

Surprisingly, it was neither the heavy-spending computer sector nor the capital intensive semiconductor sector that captured last year's top growth catagory. Instead, it was the tiny software segment that took first place with an average 1988 growth rate of 79.9%.

In dollar terms, software accounted for only 1.2% of capital spending by the top 100 electronics companies on the ELECTRONIC BUSINESS survey. At the top of the software spenders was Ashton-Tate Corp., up 459% to $36.4 million as a result of acquisitions. The company plans further expansion in Singapore this year.

Behind fast-growing software came peripherals, with a 75.8% growth rate in capital spending in 1988. It was in this category that the wildest swings took place. Seagate Technology, in 13th place last year, rose in the overall capital spending ranks from 30th place in 1987, while 45th-ranked Storage Technology Inc. plunged from 14th place as it recovers from three years in bankruptcy.

Capital spending levels



Total capital spending by the top 100 U.S. electronics companies ($ billions)

Source: ELECTRONIC BUSINESS

Expect stagnation

What's in store for 1989?

Stagnation, says Cahners Economics' Madeline Franchi. "In general, growth in business investment by electronics companies in new plant and equipment reached its peak at the end of 1988, and we are seeing some definite softening in 1989," she says. But economist Franchi anticipates a turnaround in the electronic industry's capital spending plans in 1990 and a "resurgence" in 1991 as the economy recovers from the slowdown of late 1989 and early 1990.

But industry observers say that even though the sluggish economy will slow total capital spending in 1989, electronics companies have no choice but to continue to spend on productivity-improving equipment. That means out of a smaller pie, less will be spent on increasing capacity while more will go to replacement and modernization.

Indeed, Data Resources Inc. is forecasting the percentage of capital spending devoted to expansion to drop from 32% in 1988 to 28% in 1989 for all manufacturing industry. The trend is reflected in the subcategories of electrical machinery, 29% to 21%; nonelectrical machinery, 24% to 16%; and instruments, 34% to 33%.

Compounding this shift is the ever-increasing pressure from foreign competition. For instance, the top 10 Japanese chip makers plan to increase spending by 75% to $4.8 billion this fiscal year, ending next March, while the top 11 U.S. companies will increase spending by only 22% to $3.2 billion in calendar 1989, says analyst Joseph. ☐

Top U.S. capital spenders

Rank 1988	Rank 1987	Company	Total capital expenditures ($ millions)	Change from 1987	Capital expenditures as a percentage of revenue	Capital expenditures to net cash flow after dividends	Fiscal 1988 revenue ($ millions)	Fiscal year ended
1	1	**IBM**	$5,390.0	25.2%	9.0%	70.5%	$59,681.0	12/88
2	3	**Digital Equipment**	1,517.6	102.8%	13.2%	82.8%	11,475.5	6/88
3	2	**Xerox**	1,399.0	49.3%	8.5%	167.7%	16,441.0	12/88
4	5	**Motorola**	873.0	32.7%	10.6%	96.5%	8,250.0	12/88
5	4	**Unisys**	669.9	-7.1%	6.8%	60.0%	9,902.0	12/88
6	6	**Hewlett-Packard**	648.0	27.8%	6.6%	57.9%	9,831.0	10/88
7	8	**Texas Instruments**	628.1	35.7%	10.0%	93.9%	6,294.8	12/88
8	7	**GM Hughes Electronics**	533.0	13.5%	4.7%	55.7%	11,243.6	12/88
9	11	**Intel**	477.5	58.3%	16.6%	71.9%	2,874.8	12/88
10	9	**NCR**	420.4	8.0%	7.0%	66.1%	5,989.9	12/88
11	10	**Honeywell**	327.7	7.7%	4.6%	-136.0%	7,148.3	12/88
12	12	**Pitney Bowes**	309.5	22.9%	11.7%	93.5%	2,649.9	12/88
13	30	**Seagate Technology**	284.4	262.8%	22.6%	221.7%	1,257.0	6/88
14	18	**Amdahl**	278.9	76.8%	15.5%	88.4%	1,801.8	12/88
15	22	**Wang Laboratories**	273.6	113.8%	8.9%	79.8%	3,068.4	6/88
16	23	**Compaq Computer**	273.5	141.5%	13.2%	89.9%	2,065.6	12/88
17	13	**Litton Industries**	230.1	-5.2%	4.7%	64.6%	4,863.9	7/88
18	17	**AMP**	220.3	28.2%	8.2%	59.6%	2,699.7	12/88
19	25	**National Semiconductor**	198.9	110.0%	8.1%	85.5%	2,469.7	5/88
20	20	**Tandem Computers**	185.1	30.0%	14.1%	102.6%	1,314.7	9/88
21	15	**Control Data**	169.8	-4.8%	4.7%	86.6%	3,628.3	12/88
22	27	**Apple Computer**	144.0	67.2%	3.5%	32.9%	4,071.4	9/88
23	24	**Prime Computer**	140.9	40.2%	8.8%	80.6%	1,594.6	12/88
24	31	**Sun Microsystems**	117.3	54.2%	11.2%	100.0%	1,051.6	6/88
25	16	**LSI Logic**	101.0	-42.1%	26.6%	128.5%	378.9	12/88
26	21	**Advanced Micro Devices**	97.7	-29.1%	8.7%	56.7%	1,125.9	12/88
27	19	**Data General**	96.6	-32.4%	7.1%	116.6%	1,364.7	9/88
28	26	**Tandy**	94.2	1.1%	2.5%	28.1%	3,793.8	6/88
29	33	**Perkin-Elmer**	83.6	25.7%	7.2%	94.9%	1,165.5	7/88
30	49	**Cray Research**	82.0	104.3%	10.8%	29.5%	756.3	12/88
31	28	**Harris**	81.2	-2.9%	3.9%	47.9%	2,099.3	6/88
32	32	**Tektronix**	78.1	16.9%	5.5%	164.9%	1,411.9	5/88
33	35	**Microsoft**	71.6	23.5%	12.1%	51.2%	590.8	6/88
34	41	**Molex**	68.7	38.9%	13.7%	68.5%	502.4	6/88
35	45	**Intergraph**	66.5	52.3%	8.3%	54.3%	800.2	12/88
36	63	**Micropolis**	64.0	186.8%	18.1%	-1,354.1%	353.1	12/88
37	37	**Apollo Computer**	60.3	12.3%	9.2%	141.7%	653.5	12/88
38	34	**General Instrument**	60.0	-5.0%	5.2%	46.2%	1,155.5	2/88
39	58	**Applied Magnetics**	55.5	115.5%	18.9%	137.8%	293.0	9/88
40	57	**Lotus Development**	55.2	107.5%	11.8%	57.4%	468.5	12/88
41	40	**VLSI Technology**	55.2	10.1%	24.9%	149.4%	221.2	12/88
42	38	**E-Systems**	53.7	5.1%	3.7%	57.6%	1,443.1	12/88
43	50	**Loral**	50.9	49.1%	3.5%	38.6%	1,440.8	3/88
44	46	**Analog Devices**	47.3	9.9%	10.8%	63.4%	439.2	10/88
45	14	**Storage Technology**	47.2	-73.7%	5.4%	35.7%	874.0	12/86
46	62	**DSC Communications**	45.9	97.7%	13.5%	103.0%	339.7	12/88
47	—	**Micron Technology**	44.3	877.6%	14.7%	35.9%	300.5	8/88
48	44	**Varian Associates**	43.2	-6.5%	3.7%	69.2%	1,170.6	9/88
49	52	**SCI Systems**	42.8	44.6%	5.5%	110.3%	777.7	6/88
50	68	**Maxtor**	38.1	118.8%	14.1%	153.0%	271.2	3/88

(Continued)

Top U.S. capital spenders

Rank 1988	Rank 1987	Company	Total capital expenditures ($ millions)	Change from 1987	Capital expenditures as a percentage of revenue	Capital expenditures to net cash flow after dividends	Fiscal 1988 revenue ($ millions)	Fiscal year ended
51	61	**Sprague Technologies**	$38.1	56.8%	7.6%	80.7%	$504.6	12/88
52	—	**Ashton-Tate**	36.4	459.4%	11.8%	52.0%	307.3	1/89
53	48	**Western Digital**	35.9	-11.6%	4.7%	50.1%	768.3	6/88
54	55	**Medtronic**	33.5	18.0%	5.1%	33.0%	653.3	4/88
55	36	**Zenith Electronics**	32.9	-40.6%	1.2%	68.0%	2,685.7	12/88
56	51	**AVX**	32.5	2.2%	8.0%	61.0%	408.9	12/88
57	70	**Oracle Systems**	31.0	83.3%	11.0%	55.4%	282.1	5/88
58	—	**Conner Peripherals**	30.4	75.5%	11.8%	122.5%	256.6	12/88
59	73	**Mentor Graphics**	29.3	99.3%	9.7%	62.6%	300.8	12/88
60	64	**Bolt Beranek and Newman**	28.8	29.8%	9.4%	84.9%	305.2	6/88
61	—	**Integrated Device Technology**	27.9	59.3%	23.0%	110.8%	121.1	3/88
62	43	**Avnet**	24.7	-47.8%	1.4%	38.9%	1,829.3	6/88
63	56	**M/A-COM**	23.2	-13.4%	5.5%	58.8%	424.2	9/88
64	—	**Burr-Brown**	21.3	89.6%	12.1%	83.1%	176.7	12/88
65	—	**Wyse Technology**	20.8	157.8%	4.6%	59.5%	456.6	3/88
66	—	**Concurrent Computer**	20.4	42.7%	7.8%	72.8%	263.1	6/88
67	86	**Applied Materials**	19.8	72.5%	5.5%	38.5%	362.8	10/88
68	47	**Teradyne**	19.8	-51.7%	4.3%	75.9%	462.3	12/88
69	59	**Datapoint**	19.6	-23.3%	5.9%	82.2%	330.8	7/88
70	—	**3Com**	18.9	201.5%	7.5%	61.7%	251.9	5/88
71	92	**Computer Associates**	18.9	80.6%	2.7%	11.8%	709.1	3/88
72	75	**LTX**	18.1	33.0%	10.3%	89.4%	174.8	7/88
73	74	**Stratus Computer**	17.8	28.8%	6.7%	43.4%	265.3	12/88
74	71	**Cherry**	17.8	15.0%	9.1%	92.2%	194.6	2/88
75	53	**Augat**	17.7	-39.8%	5.5%	-147.8%	321.0	12/88
76	78	**MAI Basic Four**	16.4	24.7%	3.9%	63.5%	420.8	9/88
77	76	**Kollmorgen**	15.8	16.8%	4.6%	65.3%	344.8	12/88
78	100	**Fluke**	15.7	89.1%	7.0%	68.2%	224.5	9/88
79	90	**Gerber Scientific**	15.4	45.7%	5.8%	44.9%	264.0	4/88
80	—	**Novell**	15.3	-28.0%	5.5%	40.4%	281.2	10/88
81	80	**Dynatech**	15.1	20.0%	4.1%	39.5%	367.8	3/88
82	—	**AST Research**	14.6	132.8%	3.5%	67.9%	412.7	6/88
83	67	**Digital Communications**	13.6	-28.1%	6.0%	26.5%	227.5	6/88
84	87	**ADC Telecommunications**	13.5	21.2%	7.5%	51.7%	179.9	10/88
85	—	**International Rectifier**	12.9	114.6%	7.2%	-8,571.5%	178.6	6/88
86	84	**Andrew**	12.8	10.3%	5.1%	46.1%	253.5	9/88
87	85	**GenRad**	12.4	7.3%	6.0%	119.1%	205.9	12/88
88	94	**Genicom**	12.2	29.9%	4.2%	87.3%	291.4	12/88
89	81	**Watkins-Johnson**	11.6	-5.7%	4.0%	39.4%	292.2	12/88
90	91	**Westmark International**	11.3	7.2%	3.1%	54.1%	365.3	12/88
91	95	**Marshall Industries**	10.8	17.4%	2.6%	55.1%	420.4	5/88
92	—	**Diasonics**	10.5	30.4%	3.7%	52.8%	281.6	12/88
93	—	**Measurex**	10.3	48.5%	3.9%	23.5%	265.2	11/88
94	—	**Scientific-Atlanta**	10.1	50.5%	2.0%	25.1%	508.6	6/88
95	77	**CTS**	10.0	-25.1%	3.6%	49.2%	275.6	12/88
96	—	**Wyle Laboratories**	9.4	148.8%	2.3%	93.0%	410.9	1/89
97	98	**Coherent**	9.1	6.8%	4.8%	159.0%	188.1	9/88
98	65	**Recognition Equipment**	9.0	-58.2%	3.5%	87.5%	260.8	10/88
99	—	**Mark IV Industries**	9.0	68.0%	2.2%	31.9%	403.0	2/88
100	69	**Cubic**	7.0	-59.1%	1.9%	50.3%	364.9	9/88

(Continued)

Top U.S. capital spenders by segment

Capital expenditures
FY 1988

Capital equipment

	Total ($ millions)	Change from 1987
Hewlett-Packard	$648.0	27.8%
Perkin-Elmer	83.6	25.7%
Tektronix	78.1	16.9%
Applied Materials	19.8	72.5%
Teradyne	19.8	-51.7%
LTX	18.1	33.0%
Fluke	15.7	89.1%
Gerber Scientific	15.4	45.7%
GenRad	12.4	7.3%
Total, weighted avg.	**$910.9**	**23.6%**

Communications

	Total ($ millions)	Change from 1987
Motorola	$873.0	32.7%
General Instrument	60.0	-5.0%
DSC Communications	45.9	97.7%
Bolt Beranek and Newman	28.8	29.8%
Datapoint	19.6	-23.3%
3Com	18.9	201.5%
Novell	15.3	-28.0%
Dynatech	15.1	20.0%
Digital Communications	13.6	-28.1%
ADC Telecommunications	13.5	21.2%
Andrew	12.8	10.3%
Scientific-Atlanta	10.1	50.5%
Total, weighted avg.	**$1,126.7**	**27.9%**

Components

	Total ($ millions)	Change from 1987
AMP	$220.3	28.2%
Molex	68.7	38.9%
Sprague Technologies	38.1	56.8%
AVX	32.5	2.2%
Cherry Electrical	17.8	15 0%
Augat	17.7	-39.8%
CTS	10.0	-25.1%
Total, weighted avg.	**$405.0**	**20.7%**

Computer-based systems

	Total ($ millions)	Change from 1987
Hewlett-Packard	$648.0	27.8%
Intergraph	66.5	52.3%
Mentor Graphics	29.3	99.3%
Gerber Scientific	15.4	45.7%
Measurex	10.3	48.5%
Coherent	9.1	6.8%
Recognition Equipment	9.0	-58.2%
Total, weighted avg.	**$787.6**	**28.5%**

Distribution

	Total ($ millions)	Change from 1987
Avnet	$24.7	-47.8%
Marshall Industries	10.8	17.4%
Wyle Laboratories	9.4	148.8%
Total, weighted avg.	**$44.9**	**-25.5%**

Government

	Total ($ millions)	Change from 1987
Motorola	$873.0	32.7%
Texas Instruments	628.1	35.7%
GM Hughes Electronics	533.0	13.5%
Honeywell	327.7	7.7%
Litton Industries	230.1	-5.2%
Harris	81.2	-2.9%
E-Systems	53.7	5.1%
Loral	50.9	49.1%
Varian Associates	43.2	-6.5%
SCI Systems	42.8	44.6%
M/A-COM	23.2	-13.4%
Watkins-Johnson	11.6	-5.7%
Cubic	7.0	-59.1%
Total, weighted avg.	**$2,905.5**	**19.2%**

Mainframes

	Total ($ millions)	Change from 1987
IBM	$5,390.0	25.2%
Unisys	669.9	-7.1%
NCR	420.4	8.0%
Amdahl	278.9	76.8%
Control Data	169.8	-4.8%
Cray Research	82.0	104.3%
Total, weighted avg.	**$7,011.0**	**21.1%**

Medical

	Total ($ millions)	Change from 1987
Medtronic	$33.5	18.0%
Westmark International	11.3	7.2%
Diasonics	10.5	30.4%
Total, weighted avg.	**$55.3**	**17.7%**

Microcomputers

	Total ($ millions)	Change from 1987
IBM	$5,390.0	25.2%
Compaq Computer	273.5	141.5%
Apple Computer	144.0	67.2%
Tandy	94.2	1.1%
Zenith Electronics	32.9	-40.6%
AST Research	14.6	132.8%
Total, weighted avg.	**$5,949.1**	**27.7%**

Minicomputers

	Total ($ millions)	Change from 1987
IBM	$5,390.0	25.2%
Digital Equipment	1,517.6	102.8%
Hewlett-Packard	648.0	27.8%
Tandem Computers	185.1	30.0%
Prime Computer	140.9	40.2%
Sun Microsystems	117.3	54.2%
Data General	96.6	-32.4%
Apollo Computer	60.3	12.3%
Concurrent Computer	20.4	42.7%
Stratus Computer	17.8	28.8%
MAI Basic Four	16.4	24.7%
Total, weighted avg.	**$8,210.5**	**34.2%**

Office equipment

	Total ($ millions)	Change from 1987
IBM	$5,390.0	25.2%
Xerox	1,399.0	49.3%
NCR	420.4	8.0%
Pitney Bowes	309.5	22.9%
Wang Laboratories	273.6	113.8%
Harris	81.2	-2.9%
Total, weighted avg.	**$7,873.6**	**29.2%**

Peripherals

	Total ($ millions)	Change from 1987
Seagate Technology	$284.4	262.8%
Micropolis	64.0	183.8%
Applied Magnetics	55.5	115.5%
Storage Technology	47.2	-73.7%
Maxtor	38.1	118.8%
Conner Peripherals	30.4	75.5%
Wyse Technology	20.8	157.8%
AST Research	14.6	132.8%
Genicom	12.2	29.9%
Total, weighted avg.	**$567.1**	**55.8%**

Semiconductors

	Total ($ millions)	Change from 1987
Motorola	$873.0	32.7%
Texas Instruments	628.1	35.7%
Intel	477.5	58.3%
National Semiconductor	198.9	110.0%
LSI Logic	101.0	-42.1%
Advanced Micro Devices	97.7	-29.1%
VLSI Technology	55.2	10.1%
Analog Devices	47.3	9.9%
Micron Technology	44.3	877.6%
Western Digital	35.9	-11.6%
Integrated Device Tech.	27.9	59.3%
Burr-Brown	21.3	89.6%
International Rectifier	12.9	114.6%
Total, weighted avg.	**$2,620.9**	**30.9%**

Software

	Total ($ millions)	Change from 1987
Microsoft	$71.6	23.5%
Lotus Development	55.2	107.5%
Ashton-Tate	36.4	459.4%
Oracle Systems	31.0	83.3%
Computer Associates	18.9	80.6%
Total, weighted avg.	**$213.0**	**79.9%**

Source: ELECTRONIC BUSINESS

Foot dragging in U.S. slows ATE market growth

ATE sales rose a deceptive 21% in 1988, with the strong growth coming in the Far East. U.S. chip makers don't figure to buy big in 1989 either

BY TAMMI HARBERT

The worldwide market for automatic test equipment had a good year in 1988, although many ATE companies didn't know it. The market's 21% growth in 1988 was selective both by type of ATE and by geography. Much of the growth — attributed principally to the memory chip tester arena — took place not in the mature U.S. market, but in the Far East.

While 1988 growth was deceptive, signs are pointing to a flat 1989. Nonetheless, at least two companies, Hewlett-Packard Co. in Palo Alto, Calif., and Tektronix Inc. in Beaverton, Ore., are insistent on expanding their ATE offerings into production-oriented integrated-circuit (IC) tests. Other companies have made entrees into the diagnostic systems business with electronic-beam equipment. Still other ATE firms are pointing to boundary-scan test techniques as future growth areas.

The biggest general increase in 1988 ATE purchases came in Japan, where the consumption rate grew 45% over 1987, more than twice as fast as the worldwide growth rate, according to analyst Kenneth Neff, vice president at Prime Data, a market-research company in San Jose. Japan accounted for a significant portion of the 31.8% growth in the semiconductor-test area, Neff estimates.

Although Prime Data has not yet calculated its official 1989 forecasts, the company projects flat ATE growth for the year. Growth in worldwide sales could be −5% to −10% for semiconductor testers and 0% to 5% for board testers, according to Neff.

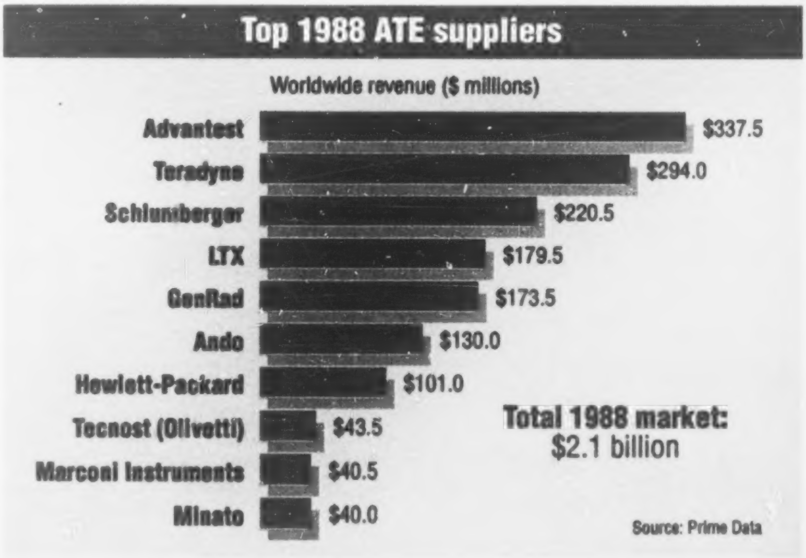
The downturn in IC testers in 1989 can be attributed to a flatter computer market and to the assumption that memory tester sales cannot continue at their high 1988 growth rates. Given the general fear about recession, companies are being more cautious about large capital spending decisions, Neff says.

U.S. semiconductor manufacturers did not buy much test equipment last year and don't intend to this year, according to Frederick Van Veen, vice president of corporate relations for Teradyne Inc. in Boston, a supplier of both component and board testers. U.S. merchant semiconductor manufacturers "are really dragging their feet on cutting purchase orders," says Van Veen, who interprets this inaction as a "lack of conviction by manufacturers about retooling their factories."

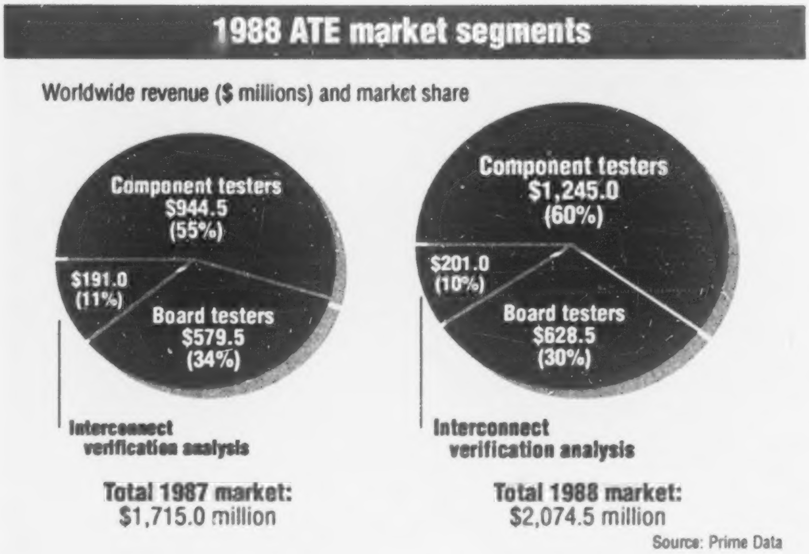
Teradyne's total revenue jumped from $55 million to $90 million in the Far East market between 1987 and 1988, Van Veen says, almost entirely due to semiconductor-tester sales. In the United States, Teradyne's total sales grew only about 10%, from $229 million to $251 million; and in Europe, 30%, from $84 million to $109 million, primarily from ATE. The demand is reflected in the company's inventory: Teradyne has a 20- to 26-week leadtime in memory testers, but only an eight- to 12-week leadtime for very large scale integration (VLSI) testers.

Increased activity?

Craig Foster, vice president of marketing at Megatest Corp. in San Jose, a $40 million private company that sells logic and memory IC testers, argues that, on the contrary, there is increased activity among U.S. semiconductor makers. Megatest's largest customer worldwide is Micron Technology Inc. in Boise, Idaho, which had total 1988 revenue of $367.7 million and net income of $121.7 million. Many U.S. companies are interested in starting DRAM production in this country,


Top 1988 ATE suppliers

Source: Prime Data



Source: Prime Data

Foster says. In June, for example, the Semiconductor Industry Association gave its blessing to the formation of a corporation to produce DRAMs, called U.S. Memories Inc. Initial supporters include IBM, Digital Equipment Corp., Hewlett-Packard, and Intel Corp.

Megatest also has a strong market position in Korea, Foster says, where he estimates the company sells about 30% of its machines. The company does not yet sell to Japan, although it has formed partnerships there and is in the process of entering that market. Foster projects 50% growth in memory tester sales, which is a conservative estimate, he says.

The surge in memory tester sales combined with the growing consumption in Japan are major reasons why Advantest Corp., a Japanese company, moved to the No. 1 position in worldwide ATE revenue in 1988. The strongest growth over the next three years for IC testers is expected to come in the Pacific Rim, according to Hiroji Agata, national sales manager for Advantest America Inc. in Lincolnshire, Ill. Korea and Taiwan, both developing quickly in memory production, will increase their capital expenditures by 100% or more each year for the next two years, he says. For example, Korea spent $13 million on ATE equipment in 1988 and is expected to spend $42 million in 1989 and $80 million in 1990. In contrast, Agata expects 10% growth in the United States market over the next three years.

Beyond memory testers, however, most IC-tester companies cite moderate to slow growth. For 1989, the market for VLSI testers could be off by 10% to 20%, says Stephen Balog, senior vice president at Shearson Lehman Hutton Inc. He attributes the downturn to a need for the industry to "sit back and belch" after heavy consumption in 1988.

In addition, he says, the semiconductor test market has a perennial problem: because it is such a small market, with only 20 or so companies that buy VLSI testers, test companies are tied too closely to the cycles of the semiconductor industry. LTX Corp. in Westwood, Mass., for example, experienced severe losses this year. This was principally due to losing orders from Intel, which had been buying $10 million worth of ATE a quarter from LTX. Suddenly in January 1989, it stopped, because of a softening demand for chips and an increase in Intel's chip yields. Consequently, LTX's quarterly revenue fell from $48 million to $25 million over three consecutive quarters, translating into a $19 million loss in the quarter ending April 1989, says Balog. In addition to the problem of a narrow market, there are simply too many companies in the IC-tester business, he says. "We really just need to have some companies go away."

Japan's ATE purchases increased 45% in 1988

On the other hand, Hewlett-Packard and Tektronix have been seeking to expand their IC test business. While for years Tektronix had been manufacturing a high-end device-characterization machine used in engineering environments, only two years ago did it enter the IC tester area. HP has been offering a high-performance analog and mixed-signal IC tester, also for two years, as well as a digital IC tester for design evaluation. Both companies cite their test and measurement expertise as business advantages and both plan to expand their product offerings.

Board testers: moderate growth

In contrast to the dramatic ups and downs of the component test business, the market for board testers had moderate growth last year and is so far holding steady this year. The board tester market has never experienced the dramatic shifts of the IC-test industry, Balog says, because it has a much broader customer base. However, companies are seeing business shift this year among several segments of the market, and they worry that a general economic slowdown could affect capital spending.

Board tester vendors have watched in fear as one after another of the minicomputer makers, including DEC, have reported disappointing 1989 revenue. Bob Anderson, president and CEO of GenRad Inc. in Concord, Mass., says business is holding steady, but "we and other companies are taking a cautious look toward the future." The workstation and PC markets are still healthy, he says. On balance, GenRad expects 1989 sales to increase 5%.

Teradyne saw sales of its high-end board testers, used mostly by the military, taper off in the second quarter. But vice president Van Veen isn't sure lower defense spending necessarily indicates a permanent lessening of demand in that sector. With slower military spending, he posits, the government may spend relatively more on electronics to refurbish older planes and tanks.

In the board test market, several companies report a shift away from

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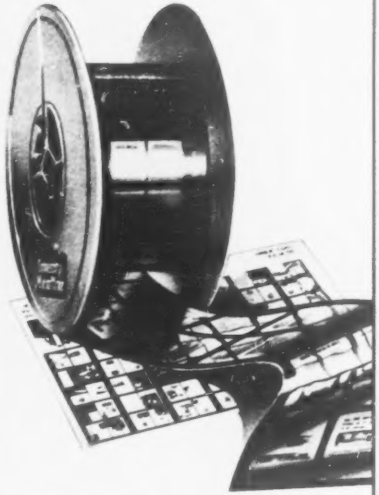

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in-circuit testing, which checks that all devices are placed on boards properly, and toward more functional testing, because of the increasing complexity of boards. That sector's growth could be 20% to 40% over the next two to three years, estimates Rick Henninger, director of marketing for Computer Automation Inc. in Irvine, Calif., a $22 million company whose ATE division specializes in high-performance functional testing. The company's functional testers are becoming less expensive and are taking less time to program, according to Jack Ferguson, director of sales.

But some companies believe functional testing may still be too expensive and time consuming to develop the software. HP, which has been in the board-test business for about 10 years, specializes in in-circuit testers with some functional capability. HP is offering a tester that is a combination of the two types, believing that is where most market growth will take place, notes Ned Barnholt, vice president and general manager of the company's electronic-instrument group. Combinational, he says, is more cost effective than functional.

The distinctions between in-circuit testers and functional testers are becoming so blurred that GenRad, the market leader in board testers, prefers to use its own classifications: process testers and performance testers. Process testers verify the board-manufacturing process and generally cost $100,000 to $500,000, according to president Anderson. Performance testers, which ensure the board functions correctly, cost $400,000 to more than $1 million. GenRad commands 32% of the market for in-circuit testers and 16% of the market for functional testers, according to Prime Data.

Bright spots

Several companies are pointing to diagnostic systems business with electronic-beam equipment as a promising area. Schlumberger Technologies in San Jose, a unit of Schlumberger Ltd., started its diagnostic business in 1987, notes Steve Harari, vice president of marketing. These diagnostic machines use electronic beams to probe IC components. Schlumberger is projecting strong growth for these systems. For example, while the company derived 10% of its revenue from diagnostic systems in 1988, it expects 15% in 1989. The company has already witnessed the increase over the first two quarters of 1989, Harari notes.

Advantest has also recently entered the E-beam business. The company sees an increasing market for such systems because of the decreasing geometries of ICs, according to Keith Lee, engineering manager for Advantest America. Below 1 micron, he says, traditional probing is no longer possible. Although the company has earned no revenue from this business yet, it is projecting that at least 10% of its revenue will come from E-beams over the next two years, national sales manager Agata says.

Another area of growth could be in machines that take advantage of boundary-scan test techniques. In May, Motorola Inc.'s application-specific integrated circuit (ASIC) division and Schlumberger's ATE division announced an $8 million agreement to develop a digital-component tester that would incorporate boundary scan. A prototype is expected in October, and delivery of five systems to Motorola is expected in the third quarter of 1990.

Beyond memory testers, most IC-tester companies cite moderate growth to slow growth

GenRad's Anderson agrees that boundary scan will become an important part of future ATE systems. The adoption of a standard boundary-scan technique, proposed by the Joint Test Action Group, an organization established in 1986 in Europe, will make it easier for ATE companies to justify the R&D investments to develop effective diagnostic software, he says. However, it will take five to 10 years before all chips incorporate boundary-scan features, he adds.

The incorporation of boundary scan in the short term will require that features be added to ATE systems, Anderson says. In the long term, if there are boards consisting completely of chips with boundary scan, he predicts, then less expensive ATE systems will be possible. ☐

Fast-blooming CVD market: Equipment makers' bright spot

As hot new consumer markets are fueling the demand for complex chips that require CVD processes, U.S. companies fight for market share

BY JOYCE A. CONNELLEY

Investors shopping for bargains in the electronics industry should take a long, hard look at the U.S.-dominated chemical vapor deposition market. In the midst of a somewhat depressed equipment market, CVD offers investors a bright spot on the horizon, one that ultimately may draw fierce competition from overseas rivals.

In fact, the CVD market fielded the only two equipment companies to go public in the last four years: Novellus Systems Inc. and Genus Inc., both of which went public in 1988.

Why all the excitement? Hot new markets for facsimile machines, car phones and even high-definition television are fueling demand for increasingly complex chips. Such products are complex enough to require several levels of interconnecting circuits, which, in turn, require a chemical vapor deposition process. CVD is a process by which a layer of either conductive or insulative material is placed on a silicon wafer to connect two or more levels of circuitry, doing so without the glitches or flaws of older furnace diffusion or sputtering techniques.

The CVD market grew 88% in 1988 over 1987, rising from $278.5 million to $523.2 million. That compares with an earlier compound annual growth rate of 28% between 1984 and 1987, according to VLSI Research Inc., San Jose, a market research firm that tracks the CVD market.

Compounded annually, CVD, which makes up 6% of the semiconductor equipment manufacturing (SEM) market, is expected to return to a relatively sedate 21.5% average growth between 1988 and 1993. But by comparison, according to VLSI Research figures, the rest of the SEM market — worth $8.2 billion in 1988 — will show a 14.8% compound annual growth rate through the same period.

William Elder, Genus' CEO: "Our competition is Japan, and we have to beat them in Japan"

Liane Enkelis

A handful of players, including Genus, Novellus Systems and Applied Materials Inc., currently dominate the market, but the consensus among analysts and executives is that CVD will be a tempting target for the Japanese, prompting potentially fierce competition in the future.

Right now, though, that competition seems to be limited to which version of CVD — insulative or conductive — will be the flavor of the day, as the Americans battle to determine who comes out on top.

VLSI Research divides the CVD market into four key segments: atmospheric; low pressure; plasma enhanced; and photo. The largest segment is plasma enhanced at $231 million, followed closely by low pressure CVD at $226.8 million. Atmospheric equipment totals an estimated $63.4 million, while photo CVD, still in early experimental stages, represents only about 0.4% of the market at an estimated $2 million.

But Genus' CEO William Elder divides the market by whether the material to be deposited is insulative (dielectric) or conductive. Mountain View, California-based Genus' products are designed for conductive applications, which include parts of both the low pressure and the embryonic photo CVD markets. But the market's size is elusive. "It all boils down to speed and density," Elder says. "The only way you can get that is through more planarization."

Novellus Systems of San Jose has

focused exclusively on the plasma enhanced segment, while Applied Materials of Santa Clara, Calif., has tried to build a machine capable of handling a variety of processes.

In a fast growing market such as CVD, the faces of competitors change as fast as the technology. This year, Applied Materials and Novellus Systems are two of the three fastest growing companies in CVD, says Dan Hutcheson, president of VLSI Research. The third is Genus. However, Hutcheson notes that in 1982, when CVD was in its infancy, none of those three firms had a presence in the market. "Every four or five years, you have a whole new set of competitors," he says.

Applied Materials offers a good example: in only two years it went from being a virtual nonplayer in the CVD market to creating an entire CVD division, representing 25% of the firm's total revenue, says David Wang, vice president and general manager of the CVD product division. Applied Materials had been in the CVD sector in the 1970s but dropped out only to re-enter. In 1988, the division's revenue topped $100 million, while the company as a whole reported $363 million.

The two start-ups, Genus and Novellus, have even more impressive revenue figures. Genus reported a 263% growth spurt from 1987's $15 million in revenue to more than $55 million in 1988. Novellus Systems' net sales leaped from $3.2 million in 1987 to $23.2 million in 1988, a 625% annual growth rate.

But those three firms are not alone in the market, nor are they largest. Advanced Semiconductor Materials International N.V. of The Netherlands, with U.S. offices in Phoenix, Ariz., boasts the biggest slice at nearly 20% of the market, according to VLSI Research. ASM's sales revenue in 1988 was $180 million; 64% of that total was derived from its CVD sector. Applied Materials holds about 15% of the CVD marketplace. Shares for Genus and Novellus Systems are estimated at 8% and 5%, respectively.

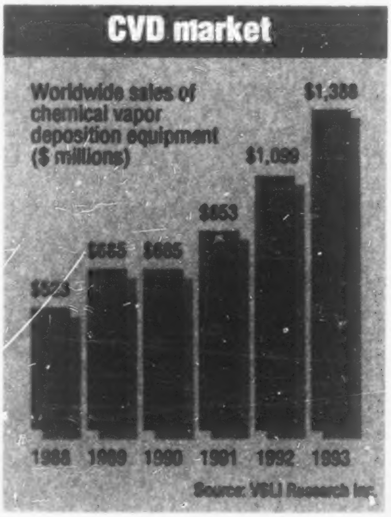
Foreign fears

Hanging on to those percentages will be difficult, even in such a burgeoning market, as other CVD competitors, mainly the Japanese, are poised to wrestle some of that share away. Among the U.S. firms expected to enter the fray is LAM Research Corp., Fremont, Calif., which recently acquired San Diego-based Monkowski-Rhine, a CVD equipment developer.

According to Robert Graham, Novellus Systems' CEO, Japanese manufacturers have had problems competing in the SEM market because their operations are geared toward mass production, while semiconductor equipment is manufactured in very small quantities.

Hutcheson of VLSI Research notes that foreign competition over the last two years has "not been that strong." But at the same time, he points out, American firms have lost market share to overseas competitors. In the early 1980s the United States dominated the SEM market with an 80% share; that has fallen to 49% in 1988, according to Hutcheson.

CVD market



Source: VSLI Research Inc.

Wang of Applied Materials counters with figures from Dataquest Inc., a market research firm, that indicate the Japanese have actually lost market share in certain segments of semiconductor equipment manufacturing. "In ion implantation and photo lithography, the Japanese have gained market share, but they've lost ground in CVD," Wang says.

Genus' Elder, however, is deeply concerned about competition from Japan. "Our competition is Japan, and we have to beat them in Japan," he says.

Europe, on the other hand, Elder says, is an "emerging" market American companies can still take advantage of.

"Companies like Genus need to be very strong internationally to succeed," Elder says. "Clearly, you need to be involved in the global marketplace because that's going to drive your future." He adds: "If you're only selling in the U.S., you're probably losing market share."

The CVD process has become so important to the semiconductor industry that some customers say it will soon make some manufacturing methods obsolete. Joe Zelayeta, vice president for manufacturing for LSI Logic Corp., Milipitas, Calif., says all semiconductor products his company turns out rely on CVD.

"Our business is very interconnect intensive," Zelayeta explains. "You have to use CVD to provide insulation between the layers."

Jack Saltich, vice president and general manager of San Jose-based VLSI Technology Inc.'s memory and technology division, says his company uses CVD processes exclusively in manufacturing.

Graham of Novellus Systems says another method that may soon be history is the depletion process. Through depletion, gas is introduced at a single point and allowed to spread out over the wafer. However, as it spreads, the gas weakens, resulting in a nonuniform layer. Graham maintains that the depletion process will be replaced by plasma enhanced CVD.

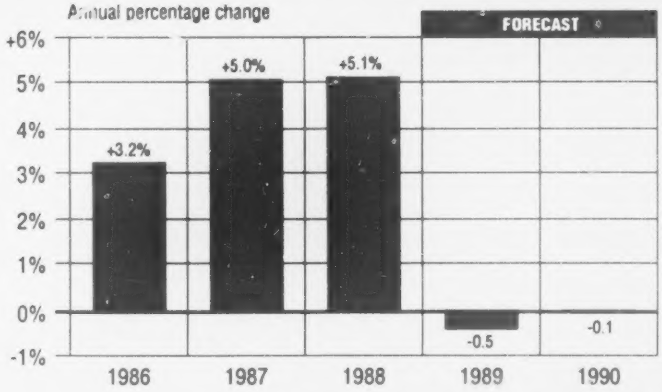
CVD's lifespan

A significant, long-range problem facing CVD equipment manufacturers is, for the moment, being ignored: How long can the industry rely on the rapid growth brought about by the technological advancements in semiconductor design? The answer seems to be: not terribly long.

According to Graham, "This market segment will continue to outperform the rest of the industry for another three to four years or so."

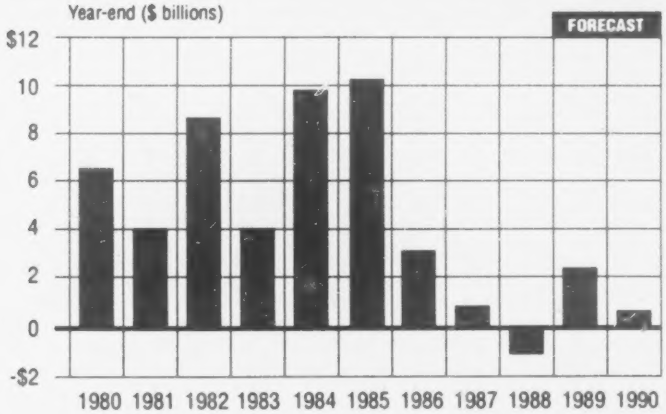
The rough prediction is that CVD will serve the semiconductor manufacturing industry beyond that time frame, but, sooner or later, another technology will surge to the forefront and supplant CVD. "Ten years ago, we saw it in lithography, and five years ago, we saw it in etch," says Graham. "Now we're seeing it in CVD." ☐

Communications equipment shipments



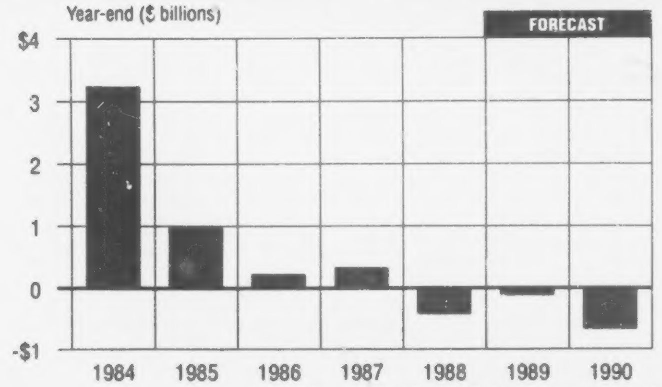
Data source: U.S. Commerce Department; Forecast: Cahners Economics

Communications equipment: Change in backlog



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Communications equipment: Change in inventory



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Slowdown won't hurt communications too much

New orders for communication equipment fell in May, declining 3.2% from April to total just under $6 billion. Weakness was most evident in the defense portion of the industry, but even on the less volatile commercial side, growth in new orders started to recede in mid-1988. Decreased demand for the products means shipments gains will be less.

Cahners Economics is forecasting a 0.5% drop in U.S. factory shipments for the total communication equipment industry in 1989 and flat growth in 1990. The turnaround for the industry is expected to start again by the third quarter of next year, so psychologically 1990 will be more upbeat as the industry begins to see demand pick up again.

One positive factor helping to stabilize this industry during the current economic slowdown is its relatively high level of backlogs. As of May, unfilled orders amounted to $64 billion, of which approximately three-fourths were for defense-related equipment. Although the military buildup of the early decade has given defense contractors a buffer, backlogs have been steadily shrinking. The current level represents a drop of 3% from a year ago.

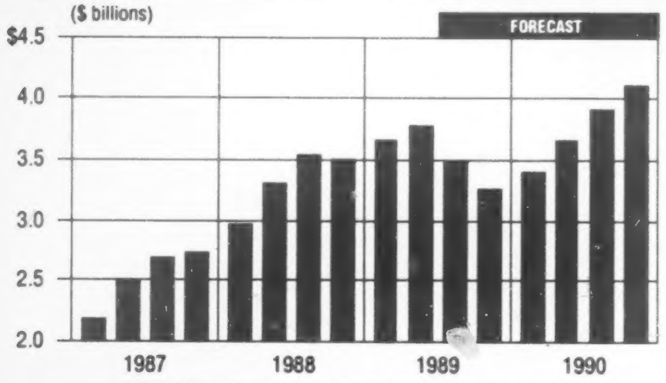
Furthermore, the industry is not going to experience as severe an inventory correction as it did in 1986 and 1987. In fact, during 1988 inventory continued to decline from the year before and has only recently started to edge up. No large inventory overhang means the industry is in better shape to weather the business cycle downturn.

A third factor working to keep the industry contraction from becoming a total disaster is the value of the dollar and the opening of some export markets to U.S. telecommunication equipment. Based on data from the American Electronics Association, exports of telecommunication equipment were still growing at a rapid pace. In the first quarter of this year, exports reached $1.21 billion, up 24.9% compared with a year ago. Even though the dollar has come back from its most recent low, particularly versus the yen and deutsche mark, it is still well below its peak of 1985. So, expect continued growth in exports, although at reduced rates.

MADELINE FRANCHI

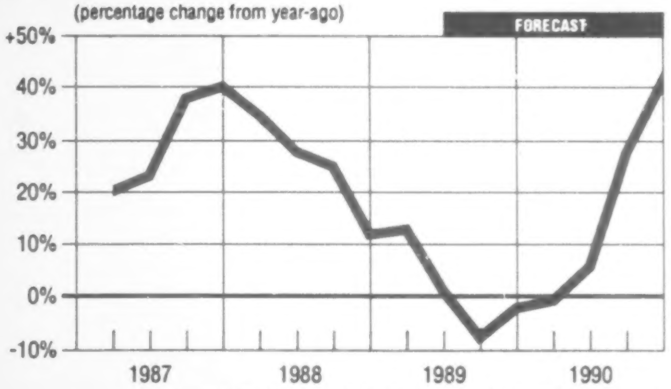
A column on communication equipment will appear again in the November 27th issue.

Semiconductor sales to North America



Data source: Semiconductor Industry Association; Forecast: Cahners Economics

Semiconductor bookings to North America



Data source: Semiconductor Industry Association; Forecast: Cahners Economics

Expansion and contraction in the U.S. semiconductor industry

		Expansion		Contraction	
		1984	1988	1985	1989
Sales	($ billions) (% change)	$11.6 +49%	$13.4 +31%	$8.1 -30%	$14.4 +7%
Bookings	($ billions) (% change)	$12.3 +33%	$14.1 +24%	$6.5 -47%	$14.2 +1%
Book-to-bill	(peak/low)	1.84	1.22	0.64	0.90
ASP*	(% change)	-42%	+18%	-16%	-5%
IC lead-times	(average weeks)	18.0	8.9	7.9	6.5
Employment	(thousands)	290	266	268	263

* ASP = Worldwide average selling price

Data sources: Semiconductor Industry Association, *Electronics Purchasing*, U.S. Bureau of Labor Statistics; Forecast: Cahners Economics

U.S. semiconductor sales to continue slow growth

Sales of semiconductors to the United States continued to grow in the first half of 1989, but much more slowly than last year. According to the Semiconductor Industry Association, sales grew 17% in May 1989 from year-ago sales volume. This growth rate is down from a 26% year-ago increase three months earlier and a 32% jump the year before.

If bookings activity is to be believed, expect sales growth to slow even more in the months ahead. Bookings grew just 2.3% above year-ago levels this past May, a far cry from the 23% gains of the previous spring.

Of course, one question is on everyone's mind in this industry: Will there be an industry-wide recession? The answer varies depending on which forecaster speaks. The absence of a consensus among the experts is indicative of the lack of clear signals coming from the economy and the industry.

Compared with the 1985 recession, the current statistics simply don't show the same volatility. Standing back in 1985 at the same point as in the current business cycle, bookings were already plummeting at an annual pace of 39%. This time bookings, although growing only half as fast as a year ago, are still managing to achieve positive growth at an annual rate of 15%.

The lack of a clear positive or negative signal means forecasters are more apt to disagree about 1989 and 1990. Yet most will agree that some kind of turning point will be coming in the months or year ahead. The only questions remaining: How low will the turning point go and when?

Don't be confused by the plethora of semiconductor forecasts. The best business plans depend on at least two forecasts, an optimistic scenario and a pessimistic one. With some realistic and accurate boundaries on your business forecast, chances are you'll succeed.

Where do Cahners Economics' forecasts fall? Right now, we're probably one of the more optimistic, with a mild two-quarter downturn in the latter half of 1989 followed by renewed growth in 1990. The pessimistic scenario: the economy hits a recession, computer orders take a bath and semiconductor prices plunge.

ELIZABETH B. BAATZ

A column on semiconductors will appear again in the November 27th issue.

SIX DOLLARS

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

SEPTEMBER 4, 1989

NINE NEW MAVERICKS

We pick the semiconductor fraternity of the '90s

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Japanese covet workstation partners PAGE 17

Board makers fight for profits PAGE 83

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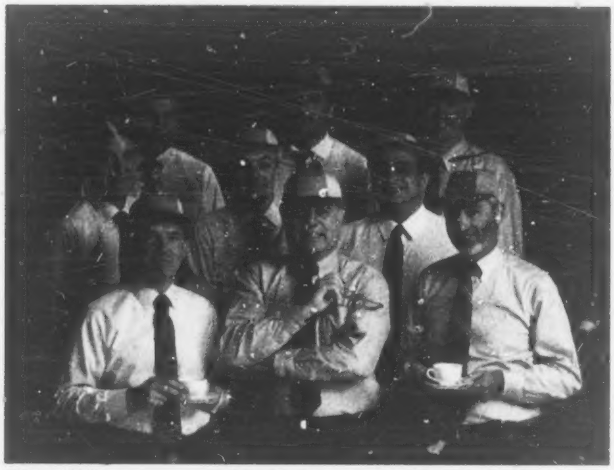
VOL. 15, NO. 18

SEPTEMBER 4, 1989



PAGE 30 Nine new mavericks: bottom row, left to right, Dan Hauer, S-MOS Systems; Michael Hackworth, Cirrus Logic; James Diller, Sierra Semiconductor; center row, Bernard Vonderschmitt, Xilinx; Vin Prothro, Dallas Semiconductor; Thomas Longo, Performance Semiconductor; top row, John Gifford, Maxim Integrated Products; George Perlegos, Atmel, and James Bixby, Brooktree.

COVER STORY/STRATEGIES

30 Nine new mavericks: Semiconductor stars of the '90s

Two years ago, ELECTRONIC BUSINESS singled out 10 ingenious semiconductor start-up companies that were models of success. Two years have shown that such a maverick approach is winning as these companies are all profitable and growing. This year, we select and introduce nine new start-ups just as successful and just as unorthodox — and just as willing to break all the rules.

BUSINESSS TRENDS

17 Japan partners its way into elusive workstation arena

If you can't beat 'em, join 'em. That's the strategy being pursued by cash-rich Japanese companies seeking to increase their lean 17% share of a rapidly growing $4.3 billion workstation market. Once there were expectations that the Japanese would play big in workstations on their own; now the thrust is to invest in U.S. manufacturers.

23 "Lightsat" contractors maneuver to meet demand

The U.S. Department of Defense has concluded that reliance on a few large, sophisticated satellites could prove fatal during war — prompting a flurry of activity aimed at developing so-called "lightsats" and creating a potential $100 million for light satellites by the early 1990s.

STRATEGIES

30 Nine new mavericks: Semiconductor stars of the '90s

1983 and 1984. They were the boom years. Years that heralded the worst semiconductor downturn in history. But they actually were a great time to start a chip company. Some of today's hottest companies were founded -- some 70 of them. As our picks for the nine semiconductor success stories of 1989 attest, these new companies are a breed apart from the humdrum, standard-offering "me-too" chip company.

36 Where are they now: 1987's superstars revisited

Two years ago, 10 maverick start-up companies began to change the way semiconductor business was done. These Silicon Valley firms were content to throw traditional chip wisdom to the wind: they focused on niche markets, in some cases didn't build fabs, and vowed to control their costs. A revisit in 1989 shows that these companies' unconventional strategies are reaping dividends. Their big challenge now is to keep their entrepreneurial flames burning.

44 The Law of the Microcosm

In this second of two excerpts from George Gilder's book on the semiconductor industry, *Microcosm*, Gilder explains his theory of the microcosm — that economics and politics have taken their cue from the overthrow of matter in modern physics. The microchip, Gilder argues, epitomizes the microcosm. In this installment, Gilder argues that the law of the microcosm favors the emergence of small entrepreneurs.

MANAGING RESOURCES

55 Merging engineering skills that give you the edge

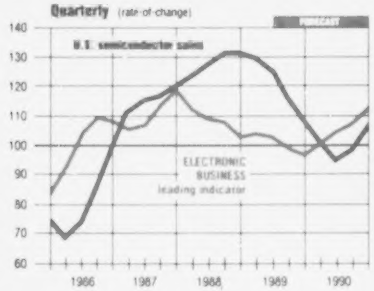
In the sixth article in a continuing series, McKinsey & Co. says many companies seeking the benefits of so-called simultaneous engineering have tried to integrate manufacturing and product engineering by having these functions report to the same person. But that fix does not go far enough. To be effective, integration has to take place at lower levels in a company.

Cover photograph: Christopher Springmann

PAGE 63 T. Rowe Price's Roger B. McNamee: "Right now it is a seller's market in DRAMs"

PAGE 79 Winbend's Yang Ding-yuan: "Semiconductors are the core of the [Taiwan] information production industry"

PAGE 44 George Gilder's The Law of the Microcosm, the second of two excerpts from *Microcosm*



PAGE 93 Business Barometer: Consensus continues, no full-fledged recession

PAGE 17 Sony Microsystems' Tom Steding: Targeting niche workstation markets

PAGE 11 Simtek's Richard Petritz: New twists for nonvolatile memory chips

63 DRAM futures trading: High tech not yet sold

Plans are afoot to begin DRAM futures trading by the middle of next year on at least two commodities exchanges. The goal is to tame price volatility in the sprawling semiconductor memory market. While the plans still are being sorted out by the electronics industry, some executives are backing the concept as a boon to companies that use DRAMs in large quantities.

EUROPE BUSINESS

74 European ASIC makers seek home-field advantage

Lured by a healthy home market for application-specific integrated circuits, European semiconductor manufacturers are mired in a struggle to expand their market share on the continent. But the challenge they face may be too much to withstand. A host of hostile conditions, including cutthroat competition from the United States and Japan, present formidable obstacles.

ASIA/PACIFIC BUSINESS

79 Burgeoning IC production bolsters Taiwan electronics

Taiwan has been the home of the cheap windup toy, the souvenir salt and pepper shakers, and the glow-in-the-dark Frisbee. But now, that nation is home to a burgeoning semiconductor industry as well. Spurred on by the government, the hope is that increased IC production will thrust the island into the big leagues of high technology.

MARKET PERSPECTIVES

83 Board makers fight for profits as growth slows

Despite healthy growth in the U.S. printed wiring board industry — the market grew 17% in 1988 to $5.5 billion — profits have been scarce. Adding to the crunch are demands for higher density packaging, improved quality and faster turnaround. To meet the stepped-up requirements, independent PCB manufacturers have been forced to invest heavily in new capital equipment.

BUSINESS BAROMETER

93 Economic outlook

The word recession may be more popular than ever these days, but Cahners Economics says there will be no full-fledged recession in the next year.

94 Leading indicator

The ELECTRONIC BUSINESS Leading Indicator dropped to 103.2 in May and is expected to fall to 95.7 in October.

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Chip-making mavericks

Editor Bairstow (far left), with bureau chief Rice (right), assistant editor McCreadie (upper far left), and the nine new mavericks.

Being different takes guts sometimes. After all, the status quo is always easier to maintain. The nine fast-growing semiconductor companies we are featuring in this issue — and the 10 we are revisiting from two years ago — have formed strategies much different from the typical well-established chip company. Our West Coast bureau manager Valerie Rice and assistant editor John McCreadie show how these maverick small companies have gone against the grain of humdrum semiconductor industry wisdom — opting for niche markets, forging strategic alliances and carefully eyeballing costs. It works, our writers say; witness these brash companies, all profitable and growing.

So if these upstart companies can be unorthodox in their approaches, why can't we do the same once in a while? Yes, those are indeed propeller beanies on the heads of the chief executives of the companies we selected as the new semiconductor success stories. We could have run your standard annual-report-type group photograph, but we say, Why not do it differently, like the new breed does? That's the way they would have done it, I'm sure.

Besides, what's good for them is also good for us. In the photograph that accompanies this column, that's a beanied editor Jeff Bairstow on the far left, with the nine executives and Rice at the right and McCreadie at the upper far left.

The idea for the beanies belongs to free-lance photographer Chris Springmann, a frequent contributor to ELECTRONIC BUSINESS. We think it is a great departure. Again, these semiconductor executives are building their futures on taking chances.

They even took their beanies home with them.

MARVIN GREENE, section editor

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BPA ABP

Nine new mavericks We pick the semiconductor fraternity of the '90s

There's a new breed of chip makers taking hold of the semiconductor world — ingenious, niche-driven start-ups quick to abandon the old rules. Nine of them best illustrate why these new generation qualities are winning

Two years ago, **ELECTRONIC BUSINESS** *singled out 10 semiconductor start-up companies that were models of success. These weren't the typical "me-too" chip companies, but a new breed who were making their own rules. Two years have shown that such a maverick approach is winning. This year, we select and introduce nine new start-ups — just as successful and just as unorthodox. And we look back to the maturing upstarts of 1987, challenged today to maintain the entrepreneurial spirit.*

BY JOHN McCREADIE
and VALERIE RICE

There was something magical about those years.

They were the boom years of 1983 and 1984 — years that heralded the worst semiconductor downturn in history, but actually were a great time to start a chip company.

Some of today's hottest companies were founded during this period, the most fertile in semiconductor history. Market research firm Dataquest Inc. estimates that 70 companies were formed during this two-year period.

But these new companies were a breed apart. Gone was the old humdrum, standard-offering "me-too" chip company. In its place were vital, energetic firms determined not to make the same mistakes as their predecessors. There's no overspending and under marketing here. And if these maverick chip makers had to abandon old rules, create new ones or just plain do without rules altogether, then so be it.

Nine chip makers, all currently profitable and growing, best illustrate such new generation qualities: Atmel Corp., Brooktree Corp., Cirrus Logic Inc., Dallas Semiconductor Corp., Maxim Integrated Products, Performance Semiconductor Corp., Sierra Semiconductor Corp., S-MOS Systems Inc. and Xilinx Inc.

These companies all had sales of less than $100 million in calendar 1988, and their leaders are experienced, street-smart executives savvy to the realities of the semiconductor business. Five of these companies don't even have their own fabs.

But being a maturing start-up is not easy, particularly in an era of declining demand, cautious buyers and megabucks competitors. As these new-breed companies head for the 1990s, they can expect stiffer competition. From hands-on management and niche marketing to strategic alliances and plain old sweat of the brow, these companies are gambling their futures that they will be the next to hit it big.

Up or down business

"The [semiconductor] battlefield is scattered with guys who just stepped a little bit on a mine," says John F. Gifford, president of six-year-old Maxim of Sunnyvale, Calif. "The most scary part of the high-tech business is there is no level ground —it's

Christopher Springmann

Our hats are off, too, to these successful semiconductor start-ups. ELECTRONIC BUSINESS found nine maturing companies headed for stardom. Their leaders are, bottom row, from left to right: Dan Hauer, S-MOS Systems; Michael Hackworth, Cirrus Logic; James Diller, Sierra Semiconductor; center row, Bernard Vonderschmitt, Xilinx; Vin Prothro, Dallas Semiconductor; Thomas Longo, Performance Semiconductor; top row, John Gifford, Maxim Integrated Products; George Perlégos, Atmel, and James Bixby, Brooktree up or it's down." Some recent minefield victims include Laserpath Corp. and Telmos Inc., according to a Dataquest survey.

But for these nine companies, the prospects are bright. More than ever, blue-chip companies such as Digital Equipment Corp. and Unisys Corp. are making volume deals with start-ups. Performance Semiconductor and Xilinx are two examples of beneficiaries. And as the industry moves into a recession brought on by contracting demand, those with the leading-edge technology will continue to win those contracts.

"Within large organizations there's been a tendency in the past to dissuade people from doing business with small start-up companies," says Richard A. Cowgill, Unisys' engineering department manager in the systems development organization. "The fact that technology is changing so rapidly today and with the cost of custom ICs — it behooves us to look at these guys."

And even technology-averse Wall Street is giving these independent-minded start-ups their due. "They have all found something different to exploit, some unique angle," explains Donaldson, Lufkin & Jenrette Securities Corp. analyst Drew Peck. "There is a value added there."

If there is a primary reason these companies are as hot as they are today, then the key may be their management strategies. Tossing aside the textbook has taught executives in these firms some hard lessons. "I learn much more from disasters than from successes," explains Dallas Semiconductor's president and CEO Vin Prothro, referring to his management style.

During his 12 years at Mostek Corp., the DRAM shortage was one disaster that taught Prothro to "always work on new products." He says, "You can't survive such shortages with only one product." Dallas Semiconductor reported revenue of $58 million in 1988, and analysts predict the company will finish 1989 with about $85 million.

Experience is a common thread among most of these executives. Gifford of Maxim has been involved in six different start-ups in his 25-year career — including Advanced Micro Devices Inc. "Ninety-five percent of everything in this business I've seen before," he boasts. And experience has shown Performance Semiconductor president Thomas A. Longo, a veteran of Fairchild Semiconductor Corp., that forming a start-up is a breeze compared with starting a division within a large company, "because there are more interferences in a large company."

This management experience has facilitated changes in the way semiconductor firms traditionally operate. Employees in these unconventional companies are rewarded with such perks as ownership, which is generally absent in larger firms. Atmel workers own 60% of their company, Maxim's, 38%.

No overspenders

Even though the new-breed chip makers are more image conscious than their forerunners, overspending doesn't pose a significant problem; they remain thrifty on purchases they feel don't matter, such as office facilities or furniture. "It took me 15 months to get a chair with wheels," Atmel's vice president for sales Jack Peckham says wryly.

And this austerity is paying off. The new breed is reinvesting a healthy average of 17% of their sales into research and development of future products, outstripping the industry's 11% average, which is calculated by the Semiconductor Industry Association. In addition, these companies have cash in the bank, ranging from Performance Semiconductor's $8 million to Dallas Semiconductor's $40 million. And all show strong revenue-per-employee figures from $128,000 at Maxim to $1 million at S-MOS, whose incredibly high figure reflects one advantage of not doing its own manufacturing — fewer employees.

One significant outcome of all this R&D spending is greatly reduced product development leadtimes. Leadtimes that were two years or longer several years ago have been cut to one year or less, these aggressive start-ups claim. "We've shortened our product development cycle times to around nine months," says Cirrus Logic's president Michael Hackworth.

Pace of funding start-ups is slowing

Start-up semiconductor companies still are thriving, but the pace is slowing.

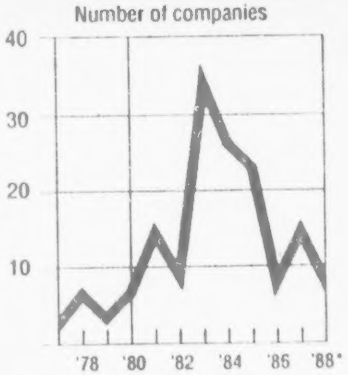
In the 10 years between 1977 and 1987, market research firm Dataquest Inc. estimates that 157 companies were started. And during the halcyon years of 1983-84, a record 70 semiconductor companies were formed. But in 1988, according to Venture Economics Inc. data, only 11 start-up semiconductor companies received funding for the first time that year; this figure does not include privately funded companies. By comparison, Dataquest research tracked 15 start-ups formed in 1987.

Venture capital funding is decreasing as well. According to Venture Economics, a research and consulting firm, chip vendors raised $115 million in venture money in 1988, down from $149 million in 1987. The number of financing rounds also fell, from 57 in 1987 to 45 in 1988.

Semiconductor companies represent a larger share of technology funding as a whole — up to 33% of the total number of financings in 1988, despite the total dollar value for the electronics industry falling last year to $259 million from $350 million in 1987.

VALERIE RICE

Semiconductor start-ups

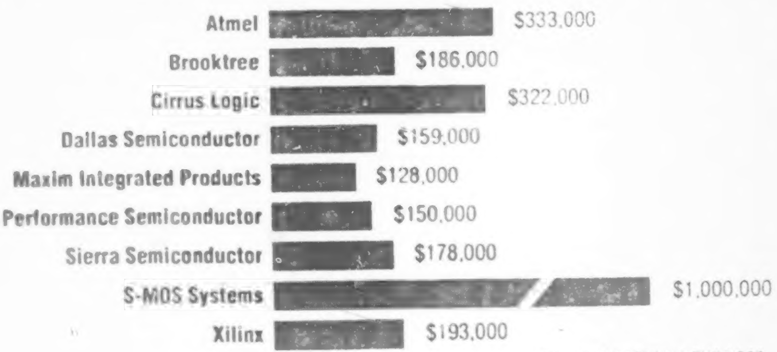


* ELECTRONIC BUSINESS estimate

Source: Dataquest Inc

Upstarts' 1988 revenue per employee

1988 calendar year sales/average number of employees in 1988



Source: ELECTRONIC BUSINESS

The importance of shortened cycle times cannot be underestimated. For small companies, time to market is everything. And when the market is a niche — often tasty market opportunities for larger companies — time to market is even more critical.

Niches: the lifeblood

Niches are the lifeblood for these start-ups. But picking the right niche can be crucial to a start-up's success. It is common for start-ups to zero in on markets too small for large American or Japanese companies to care about. Often, though, niches become trendy, bringing in fast and furious competition.

The hard disk drive market is one example of a sizable niche that went undetected by big companies. In 1989, that market will ship more than21 million units, all of them containing a drive controller, valued at $24 billion, projects market research firm Disk/Trend Inc.

"It was the first market we targeted because it has a large demand and the customers are entreprenuerial themselves," says Cirrus Logic's Hackworth, whose firm sold $29 million worth of chips last year. That figure is expected to double in 1989. And, perhaps, Hackworth has an even more narrow niche in mind. "We only call on customers we can ride our bikes to or drive to," he jests. Luckily for Hackworth, most of his customers are in his Silicon Valley backyard.

S-MOS Systems is staying in its backyard, too, giving niche marketing a new twist. On the face of it, S-MOS Systems' target market of SRAMs looks like anything but a niche, but the San Jose company is "chartered to sell to only the United States and Canada," says president Dan Hauer. "That's the type of company we are. We are focused solely on the region we are in."

Because S-MOS Systems is focused, "we can do a better job serving our customers," Hauer explains. He notes that the company had sales of $96 million last year, making it the sixth largest supplier of SRAMs worldwide. Because S-MOS Systems is 58% owned by Seiko Epson Corp., the Japanese giant handles both the foundry and the sales in Japan. A separate company has been established by Seiko Epson to sell S-MOS technology to the European market.

Nine new mavericks at a glance

Company/ location	Top executive	Calendar year 1988 revenue ($ millions)	Key products	Ownership (founded)/ Original funding	Current number of employees
Atmel San Jose, Calif.	George Perlegos	$60	EPROMs, EEPROMs	Private (Dec. 1984) Private investments	928*
Brooktree San Diego, Calif.	James Bixby	44	High-performance data conversion devices	Private (May 1983) Private investments	305
Cirrus Logic Milpitas, Calif.	Michael Hackworth	29	Mass storage/communications/ graphics controllers	Public (Nov. 1984) Venture captial	206
Dallas Semiconductor Dallas, Texas	Vin Prothro	58	Low-power CMOS memory, microcontroller circuits	Public (Feb. 1984) Venture capital	600
Maxim Integrated Products Sunnyvale, Calif.	John F. Gifford	36	CMOS/bipolar analog	Public (May 1983) Venture capital	386
Performance Semiconductor Sunnyvale, Calif.	Thomas A. Longo	30	High-speed SRAMs, RISC MPUs, logic devices	Private (Oct. 1984) Venture capital	375
Sierra Semiconductor San Jose, Calif.	James Diller	49	Mixed-signal ASICs, standard products	Private (Nov. 1983) Venture capital	310
S-MOS Systems San Jose, Calif.	Dan Hauer	96	ASICs, SRAMs	Private (Nov. 1983) Private investments	147
Xilinx San Jose, Calif.	Bernard Vonderschmitt	27	User programmable gate arrays	Private (Feb. 1984) Venture capital	180

* Atmel acquired three fab facilities from Honeywell July 1989

Source: ELECTRONIC BUSINESS

Besides a clearly defined market focus, much of the success of the nine new-era semiconductor companies can be attributed to alliances, those strong relationships with big players who can provide financing and manufacturing assistance. Sierra Semiconductor, whose founders left National Semiconductor Corp. to establish the company, has managed to maintain a solid rapport with the chip giant, a unique feat in an industry in which many breakaway start-ups end up in court for patent infringement.

"We've joint-developed products and lease a [$30 million] clean room in Singapore from National," says Sierra president and CEO James V. Diller, an industry veteran who worked at National from 1969 to 1983. Sierra's sales last year reached $49 million. "We have all the benefits of a fab without the costs associated with it," he says.

Lack of manufacturing

Since five of the nine companies — Brooktree, Cirrus Logic, Maxim, S-MOS and Xilinx — have no fabrication facilities of their own, they also have had to fight a certain amount of prejudice against their status as nonmanufacturers. Here again, alliances, with several, preferably large, companies can mean the difference to a sale.

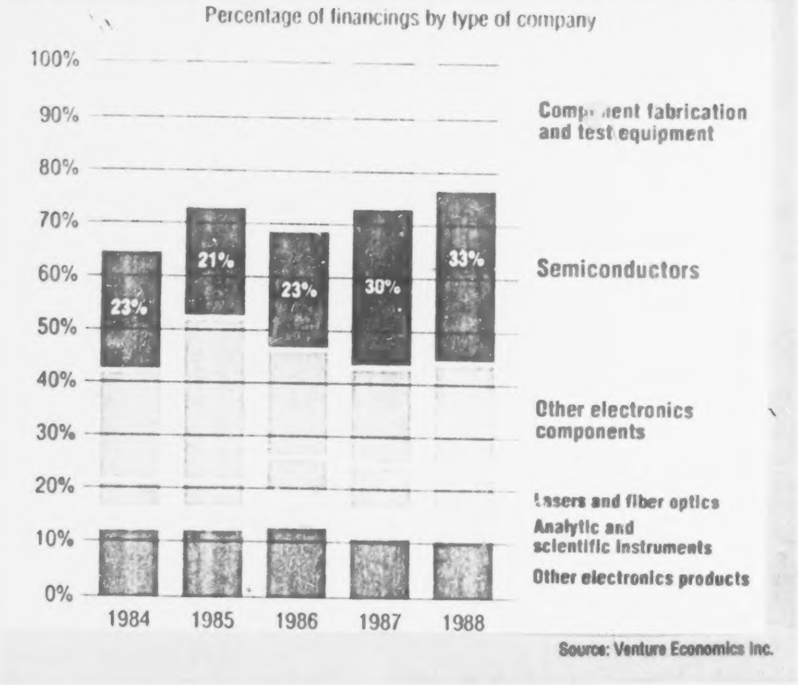
When Brooktree discovered a quality problem at one of its seven outside fabs, its multiple foundry strategy paid off. "Having foundries allowed us to switch production to another fab while we fixed the problem at the one fab," says Brooktree president James Bixby.

Flexibility is the strongest incentive for working with foundries

And all of the start-up executives, along with some of their customers, agree that such flexibility is the strongest incentive for working with foundries. But alliances are important as a means of financing as well. S-MOS Systems, for example, has the Hattori family, owners of Seiko Epson, as private investors.

Relationships do not always have to be with a large, established company to be effective. Performance Semiconductor's alliance with the very young and very successful Mips Computer Systems Inc., a leader in the RISC technology race, has been important to the start-up's success. According to Longo, Mips' RISC microprocessors will account for nearly $8 million in Performance Semiconductor's sales this year and as much as $20 million in 1990.

Venture capital financing for electronics companies



Source: Venture Economics Inc.

Performance Semiconductor also recently finalized a deal with DEC for an $8 million microprocessor contract that was won, in part, because of his company's "good relationship with Mips," says Longo.

Customers also want alliance-type relationships with their semiconductor vendors. Disk drive vendor Conner Peripherals Inc. works closely with Cirrus Logic because it offers a unique chip "we can't get anywhere else," says Bill Schroeder, Conner vice chairman and president of the new-products group. "Our strategy," notes Schroeder, "is to pick a core vendor and work with it as a system. We make our vendors our partners."

Breaking the rules

"Daring" is an appropriate description for these nine newcomers, content to break rules in a way their predecessors never thought possible. "One of the standard semiconductor rules we broke was to enter the military market early on," says Atmel president George Perlegos. Generally speaking, analysts say, small companies are seen as too weak to support the quality and reliablity demands placed on them by the military. But by focusing on documentation, standards and tight relations with customers right away, Atmel overcame the tough military barriers, making it a $60 million company last year. The company recently completed the purchase of three fab facilities located in Colorado Springs from Honeywell Inc. for an undisclosed amount.

Performance Semiconductor also entered the military sector early on with its microprocessor chips. Longo says his company had no problem securing military business — "mostly because I was known in that area due to my experience at [Fairchild]." Serving more than 100 military companies, that market accounts for 25% of Performance's $30 million business last year.

Maxim's Gifford also defied traditional semiconductor wisdom when he wrote up a simple three-page business plan proposing an ambitious strategy of developing 15 to 20 new products each quarter. "That was unheard of then," he says. Based on Gifford's semiconductor and start-up experience, investors thought his "slam-dunk" plan was a sound one. And Maxim has kept to that plan, creating about 67 new linear products each year.

Brooktree's founders broke the most cardinal rule of all — no previous semiconductor experience. Bixby was director of engineering at Spin Physics-Eastman Kodak Co., a magnetic recording head manufacturer, but that lack of a semiconductor background has not deterred him as his company reached $44 million in sales last year. "You have to really believe you can succeed," he says with the fervor of an evangelist.

This early success notwithstanding, there remain many challenges ahead for these nine start-ups. Success only serves to render them more visible in the marketplace, bringing increased competition, often from large American and Japanese companies, as well as litigation.

Cirrus Logic, for example, garners stringent competition today in drive controllers from such companies as Adaptec Inc. and International Microelectronic Products Inc. Hackworth's solution is to not license his technology to anyone, using, like Intel Corp., a sole-source strategy. Maxim, meanwhile, which carved out a niche in high-performance CMOS analog, has a unique view on protecting its market: "We're kind of like a porcupine," explains Gifford, "there's no place to grab."

"The only thing you can do is do everything you can to protect yourself," stresses Xilinx president Bernard Vonderschmitt of his $26.5 million business in 1988. "Intellectual property protection is important. You have to try to make it extremely difficult for computers by building as many walls as you can." Xilinx was sued three months after its funding in a suit brought by Zilog Inc. in Campbell, Calif., concerning misappropriation of intellectual property. That suit was settled out of court for less than $100,000, says Vonderschmitt. Today, Xilinx budgets from $200,000 to $250,000 each year for patent searches and preparing patent disclosures, says Vonderschmitt.

The leaders of these start-ups are experienced, street-smart executives savvy to the realities of the semiconductor business

Lawsuits are common risks shared by all of these high-tech companies. Atmel is involved in three suits brought against it, all concerning intellectual property rights, including one with chip giant Intel, according to marketing vice president B. Jeffrey Katz. While he won't reveal the costs of fighting those suits, Katz nonetheless calls the expense "substantial." Says Katz: "The more successful you are, the more attention you attract," adding that attention often results in patents being challenged.

Facing the future

As these companies face the new decade, competitive challenges will only increase. Perhaps the biggest worry is determining how quickly or slowly to allow the company to grow. Most of these companies have lofty ambitions — and business plans to match. The words "billion-dollar company" fall trippingly from the tongues of many of these executives. But making sure that the next two years are as successful as the last two can't be done just with ambition.

As companies grow, the focus, drive and energy that makes them successful tends to fade, notes Maxim's Gifford. The biggest risk is that management pulls away from employees, creating a gap between the hands-on producers and the company's visionaries. "If you can no longer be one of [the employees], you lose something," he says. "That's one problem there is no solution to." ☐

Semiconductor start-ups cautiously stalk the stock market

The volatile rise and fall of high-technology fortunes on Wall Street is only too familiar to today's semiconductor start-ups.

The nine semiconductor start-ups selected by ELECTRONIC BUSINESS were witnesses to the worst stock market plummet since the Great Depression. A few could have easily been casualties of a poorly timed public stock offering.

As a result, many of these chip executives are moving forward on initial public offerings, but with extreme caution.

These executives are continuing to reap the rewards of being private, while waiting for stronger market conditions to optimize investor return.

"We took a serious run at it at the end of 1988, but then technology stocks took a slide," says president James Bixby of Brooktree Corp. "So we stopped, backed up and asked, 'Why are we doing this?'" Advantages to remaining privately held include keeping sales and profit numbers under wraps and being able to maintain a more long-term market focus.

Going public

According to Bixby: "Once you go public, you get a lot of pressure from analysts and investors to keep earnings up [from quarter to quarter]."

Even Michael Hackworth, president and CEO of Cirrus Logic Inc., which went public in June, admits it was a tough decision on how to time the offering.

Yet Cirrus Logic's transition into the public sector has been successful, its stock selling an average of $2 over the initial $10 asking price. Besides making his customers and investors more comfortable by going public, Hackworth says the biggest advantage has been the increased visibility his company has received.

JOHN McCREADIE

Where are they now: 1987's superstars revisited

Two years ago, 10 start-up companies began to change the way semiconductor business was done. Their challenge now is to keep their entrepreneurial flames burning

BY VALERIE RICE

Two years ago, 10 aggressive start-up semiconductor companies planned to change the way the semiconductor business works — or die trying.

These 10 Silicon Valley firms were content to throw traditional chip wisdom to the wind: they focused on niche markets, in some cases didn't build fabs and vowed to control their costs [ELECTRONIC BUSINESS, Aug. 15, 1987]. A revisit in 1989 shows that these companies' unconventional strategies are reaping dividends.

The 10 companies — Adaptec Inc., Altera Corp., California Micro Devices Corp., Catalyst Semiconductor Inc., Chips and Technologies Inc., Cypress Semiconductor Corp., Linear Technology Corp., Orbit Semiconductor Inc., Vitelic Corp. and Weitek Corp. — all are currently profitable, growing fast and, in many cases, leaders in their fields.

Consider some impressive accomplishments already attained by several of the newcomers: Chips and Technologies, Adaptec, Cypress Semiconductor, CMD and Linear Technology all placed among the 100 fastest-growing California companies in 1988, according to *California Business* magazine; Cypress and Orbit were rated among the 10 fastest-growing IC companies in 1988 by Integrated Circuit Engineering Corp.; Chips and Technologies, Altera and Cypress consistently rank among the top five public semiconductor companies in net profits and gross margins, according to Montgomery Securities; and Chips and Technologies is No. 192 on this year's ELECTRONIC BUSINESS 200 listing of U.S. electronics companies.

In terms of standard industry indices, the ELECTRONIC BUSINESS superstars of 1987 still are outpacing well-established chip companies. Cypress leads the pack by spending 25% of sales on R&D, while the other nine average a solid 15%. Meanwhile, for 1988, the industry at large invested a paltry 11% on R&D, according to the Semiconductor Industry Association. And gross margins for these upstarts, taking into account the dramatically different product areas, are generally higher than average; at such companies as Altera, margins are as high as 60%. Revenue per employee ranges from $90,000 to more than $200,000. Chips and Technologies' revenue-per-employee average, according to the firm, was about $525,000 in fiscal 1988.

If nothing else, these 10 companies can call themselves trend setters, credited with changing the way Wall Street views semiconductor firms. This "auspicious group" of 10, as one analyst calls them, has made it easier for the next round of hot start-ups to find funding, go public and find a sympathetic purchasing ear in large companies. They have also made being fabless chic.

But now these one-time rebels are growing up — facing a future that for the first time includes competition in high-profile markets such as microprocessors and the challenges inherent in managing fast growth. Success has had its price, though. Many of these companies are tempting targets for intellectual property litigation, and several have been sued by larger companies. Their future, certainly, is contingent on how well they navigate such territory.

Growing up fast

Growing fast has other perils, too. What keeps Cypress Semiconductor's flamboyant founder and president T.J. Rodgers up at night? It is the fear his company will go the way of Advanced Micro Devices Inc., a promising 1960s start-up, says Rodgers, but a poor performer as a mature company. "I don't want to see Cypress following a death curve," he stresses.

Rodgers' statement rings true for his fellow executives at the other nine companies, who worry that the firms they built on a departure from traditional semiconductor wisdom will wither as they move into the next phase of growth. There is only one solution: "We're sticking to our knitting," says Linear Technology president Robert Swanson.

Adds Adaptec's president John G. Adler, "We are not a start-up anymore, but we have to continue to foster that kind of impatience. We have to be result oriented." Adler gives a lot of the credit for the company's success to his management team. "I know we have a seasoned management team," he jokes. "We all have gray hair."

At Weitek, president Arthur Collmeyer is managing his operation by creating small business units, respon-

The top executives of the revisited 1987 semiconductor start-ups are, bottom row, from left to right: Gary Kennedy, Orbit Semiconductor; Gordon Campbell, Chips and Technologies.; Chan Desaigoudar, California Micro Devices; Robert Swanson, Linear Technology; top row, Arthur Collmeyer, Weitek; Rodney Smith, Altera, and John Adler, Adaptec

Christopher Springmann

sible on a profit and loss basis to target, develop and market products. This way, according to Collmeyer, the management stays flat, and the company retains the feel of a start-up without the size constraints of a start-up.

But Weitek has an advantage that makes managing the company easy. It has a leader who does not want to run a large company. In fact, Collmeyer says he does not want to develop products that will turn into high-volume sellers. Nonetheless, Weitek grows: The company had $35.2 million in sales last year and is projected by semiconductor analysts to grow to about $60 million by the end of this year.

Rodgers is putting a different twist on an old management strategy — funding subsidiaries to keep employees' interest levels high. "In our first two years, we rolled out 64 products," he explains. "Over the next two years, our product introduction rate was down by a factor of two. In order for us to grow, we had to continue to roll out new products at a fast rate. It is our lifeblood. That's why we have spun off some separate companies, to keep the product innovation going."

Cypress currently has four subsidiaries and is considering funding start-ups "all the time," Rodgers says. In fact, Rodgers has been widely quoted as saying he wants to run a $1 billion company made up of 10 $100 million companies.

With opportunity knocking around every corner, these executives admit it is difficult to limit the number of areas they will explore. With so much opportunity, its easy to diversify too quickly. Yet to stay ahead of much larger competition, it is vital to react quickly.

Chips and Technologies, while still a leader in IBM-compatible chipsets, has diversified into graphics markets, among other areas. And when that market gets too crowded, its founder, president and CEO Gordon Campbell can easily shift from one product area to another. Morgan Stanley and Company Inc. analyst Andrew Kessler notes that "Chips has done a good job hopping from one area to another when the barriers go down. They're in a good position. They are a model company for no-cost no-fab production."

Although Chips and Technologies' strategy may combine focus with fluidity, others, such as Altera, are concentrating solely on one area: programmable logic. "We are still highly focused on our original strategy [in our niche]," says Altera's president Rodney Smith. But Altera is no longer alone in that niche. Xilinx Inc., a member of the ELECTRONIC BUSINESS start-up Class of 1989, rates as a tough competitor. But Smith contends his company is staying ahead of the competition. "Last year's revenue of $38 million came from five-year-old technologies and parts," he says. "Last fall, we announced the second-generation architecture, and that is spurring our sales on even faster."

In a word, Smith adds, Altera is "swamped. We can't ship enough parts fast enough to meet our demand."

Linear Technology also is "suffering" from the same overwhelming demand, says president Swanson, who has not deviated from his intention to make his firm "the industry's leading linear market specialist company." Swanson has succeeded so well that he paid "a hell of a lot of taxes in fiscal 1988." The company reached $64.7 million at the end of June 1989 — meaning undoubtedly higher taxes, Swanson moans.

In any case, Linear Technology's only change in strategy was its recent assembly, test and finish operation expansion into Singapore, its offshore venture. "We were the first to recognize that analog is not dying — it's growing," he stresses. "It's gone from a $2 billion market to $8 billion since we started the company, and it's going to keep going." For Swanson, as with most linear companies, the challenge will be to continue to introduce a large number of products. "No one circuit is going to hit a home run. We have to introduce lots and lots of circuits," he says.

Catalyst Semiconductor, meanwhile, has broadened its strategy to include both the automotive and consumer markets, and while president and founder B.K. Marya is somewhat leery, he says it is possible "to have a presence among the skyscrapers." The trick, Marya says, is to make sure the company grows slowly and in a controlled way. "I thought we couldn't get in to automotive and consumer markets, but we've done it." he says proudly.

Adaptec has altered its strategy slightly, refocusing markets away from end users and toward OEMs, says Adler. "We have been in a minefield," he says of his company's disk controller business. "Now we are in a beautiful park." But he adds with a note of caution, "I'm still waiting for a hand grenade."

Today, Adaptec does about 40% of its business in chips, up from one-third of its business two years ago. The real change is that Adler has taken the company into the broader peripheral chip-board market, lessening its dependence on the highly volatile disk drive market.

Cypress has diversified dramatically over the last two years, adding Sun Microsystems Inc.'s Sparc chip to its portfolio, among other products. Although the company has a subsidiary, Ross Technologies, to work on the architecture, it will still be a challenge for Cypress to move strongly into the big-dollar processors market. Alice Leeper of market research firm Dataquest Inc. notes that "Cypress is doing the most exciting leading-edge work on Sparc. It could be very big for them in the future."

Orbit Semiconductor maintained a steady course over the last two years, but president Gary Kennedy feels his 100% chip foundry business still "gets no respect." Kennedy says his $21.5 million in revenue last year entitles him to some kudos. "They never thought a pure service company could make it," he remembers. "We've done it, but it is still hard to be taken seriously when you don't have any products."

Serious contenders

Despite Kennedy's view, these companies are taken seriously and have set the pace for other new start-ups, such as Cirrus Logic Inc. and Maxim Integrated Products, to go public.

"Not until this year has Wall Street accepted the notion that design houses can add value without manufacturing," says Donaldson, Lufkin & Jenrette Securities Corp. analyst Drew Peck. "They are finally seen as real firms. Chips and Technologies has paved the way for other fabless companies."

Despite this sweet validation, some companies are a bit surprised at their success. "We are bigger right now than what I had planned," according to Catalyst Semiconductor's Marya. And old habits die hard. "We are still buying used furniture for our offices. I have a wooden desk now, but it's used. I want to run this company the old-fashioned way. We have nobody to impress but ourselves." ☐

Upstarts revisited at a glance

		Calendar year revenue ($ millions)			
Company	Top executive	1988	1986	Key products	Current number of employees
Adaptec	John G. Adler	$61	$52	Disk controllers	570
Altera	Rodney Smith	38	10	PLDs	250
California Micro Devices	Chan Desaigoudar	28	10	Telecom data acquisitions devices	290
Catalyst Semiconductor	B.K. Marya	15	1	EEPROMs, smart card ICs	75
Chips and Technologies	Gordon A. Campbell	180	41	PC chipsets	450
Cypress Semiconductor	T.J. Rodgers	139	16	PLDs, SRAMs, RISC MPUs	1,313
Linear Technology	Robert Swanson	59	28	Linear ICs	535
Orbit Semiconductor	Gary P. Kennedy	19	13	MOS foundry services	108
Vitelic	Alex Au	37	1	High performance DRAMs, SRAMs	220
Weitek	Arthur Collmeyer	35	17	Math processors	185

Source: ELECTRONIC BUSINESS

European ASIC makers seek home-field advantage

The Europeans' superior knowledge of their growing home market may not be enough to catch the front-running Americans and Japanese

BY VALERIE RICE

Lured by a healthy home market for application-specific integrated circuits, European semiconductor manufacturers are mired in a struggle to expand their market share on the continent. But the challenge they face may be too much to withstand, as a host of hostile conditions, including extreme pricing pressures and cutthroat competition from the United States and Japan, present formidable obstacles.

Foreign firms undisputedly claim a hefty portion of Europe's estimated $600 million ASIC market already, causing European manufacturers to try to block further advances by embracing U.S. partnerships, enhancing customer service and playing their home-court advantage.

Yet that strategy may fall short. The Europeans are doing battle with some of the biggest global players from both the United States and Japan; they are not primed to win. While the Europeans have superior knowledge of their territory, they are sorely disadvantaged by their sluggish start in the ASIC market.

U.S. and Japanese companies are way ahead. LSI Logic U.K. alone claims to have a 20% share of the European market, mirroring Milpitas, California-based parent LSI Logic Corp.'s worldwide strength. And even while Europe's biggest chip makers — N.V. Philips GL, Siemens AG and SGS-Thomson Microelectronics — struggle with the ASIC market, smaller U.S. firms are already learning to compete. As with the U.S. market for ASICs, the European market is cutthroat, competitive and underpriced.

Yet, because the European ASIC market is growing at a healthy rate, the stakes for all players are high. Gate arrays are expected to be worth $388 million this year. By 1992, however, the market will almost double in size to $726 million, predicts San Jose-based market research firm Dataquest Inc. Cell-based ICs will account for $188 million this year, but that is projected to more than double to $416 million by 1992. Programmable logic devices will sign in at $155, growing by $60 million over the next three years to $215 million, estimates say.

While it is evident that Europeans do not dominate their home ASIC market, precise market share figures are difficult to determine, analysts say. Market research manager William J. McLean of Integrated Circuit Engineering Corp. asserts that "none of the Europeans are in the top 10 suppliers of ASICs worldwide."

The reasons are telling: European companies lack the competitive pricing, cutting-edge technology and savvy marketing skills of their rivals from the United States and Japan.

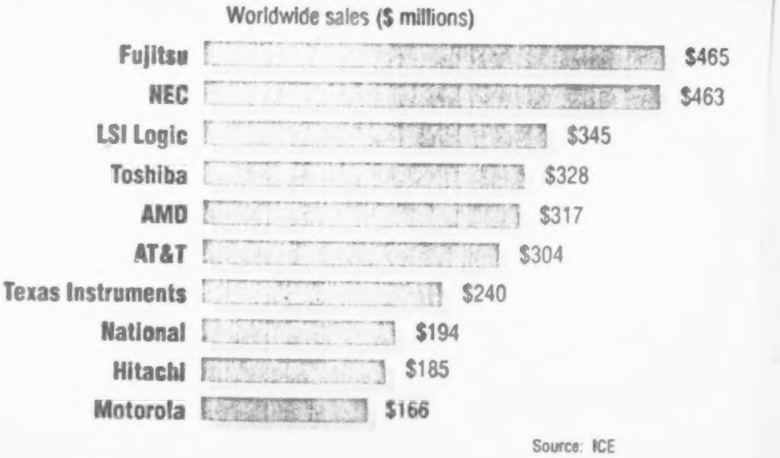
"In ASICs, European companies are just not competitive," declares Juergen Laumann, electronic/electromechanical purchasing manager of West German computer giant Nixdorf AG.

Despite a stated bias toward European manufacturers, Laumann is frustrated with his compatriots' chip offerings. He is forced to go to American or Japanese suppliers for lower prices, but most often for their superior technology.

Although their operations are structured much like Japanese companies with much the same overhead and internal needs, European firms were poised to be the first to supply the new ASIC technology to their customers. But instead, LSI Logic beat them to the punch in setting up shop on the Europeans' home turf. European companies, such as Germany's Siemens, did not enter the merchant market until last year.

Europe chip makers have limited their own access to important markets because of their slow product in-

Worldwide 1988 top ASIC suppliers



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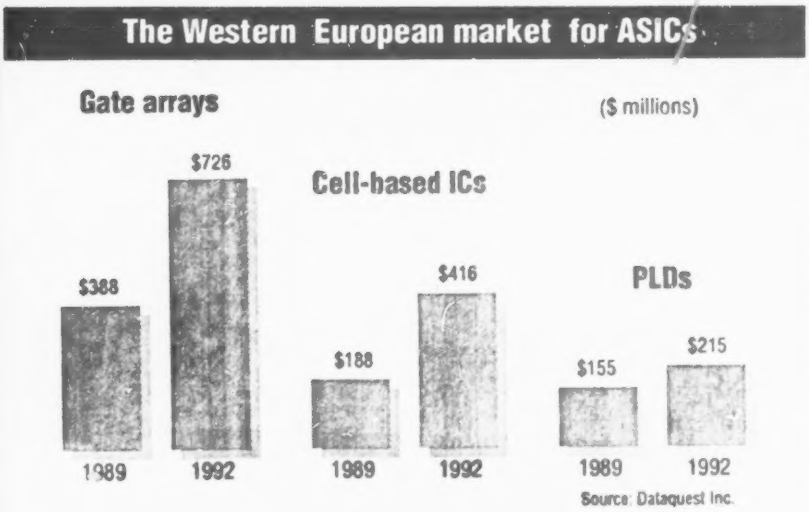

The Western European market for ASICs

Source: Dataquest Inc.

troductions. "Timing is critical," stresses Siemens' ASIC strategic marketing manager Hans-Peter Bette. "We have to introduce the products at the right time for us to support them. We have to be competitive with the external marketplace."

But that marketplace is way ahead of Siemens today. Admits Bette: "You can never be too early." Through partnerships, though, Siemens is trying to make up for lost time. It recently extended a deal to Toshiba Corp. for standard cells into the gate array arena. And Philips, based in The Netherlands, also has an agreement with San Jose-based VLSI Technology Inc. to second source its standard cell family.

Although SGS-Thomson is investing heavily in ASICs, "We are not so deep into semicustom as American companies are," says Giuseppe Zocchi, executive vice president for research and development in Agrate, Italy. "It is a big priority for us to get more heavily into semicustom," he says, "and it is one thing we don't have to buy from the Japanese."

Deal making and new investment by European firms, however, might be stymied by currently depressed prices for run-of-the-mill ASICs in Europe. The Japanese, for one, are putting heavy pressure on prices, and the Europeans can't cope with severe price cuts.

Philips Components managing director Heinrich Hagmeister notes that there is tough price competition in Europe today, especially at the initial nonrecurring expenses (NRE) level, where about half the costs are taken up in design. "There is one problem with charging for the NRE," he says. "You can't get your cost. The Japanese are very aggressive, so one result is that customers sometimes expect too much. If the business doesn't make money, that is the wrong approach."

One way the Europeans are fighting back is by giving European customers two benefits the Japanese can't yet match: superior customer service and local manufacturing. The general consensus among market watchers and executives is that most Japanese companies have targeted Europe as their next manufacturing site, and the European advantage may soon disappear.

The Europeans are sorely disadvantaged by their sluggish start in the ASIC market

In the meantime, there is discussion in the European chip community of setting fair market value pricing on ASICs, particularly gate arrays. That move could slow declining prices, but Europeans are skeptical of the measure. "It took us four years to reach an agreement on values for DRAMs," says one semiconductor executive. "Now that we have, there is a shortage and prices are high. I can't afford to wait another four years for an ASIC agreement."

But U.S. ASIC vendors in Europe are suffering pressure from the Japanese as well. "The Japanese want to get market share here," says VLSI Technology GmbH's Dieter Metzger, based in Munich, West Germany. But he claims that the "Japanese are even more agressive in Europe [than they are in the U.S.]." Adds Stephen Forte, president of Sierra Semiconductor B.V. in The Netherlands: "The Japanese have picked here as a battleground; they are going to kill everyone."

But the impression that the Japanese are going to steamroll the competition in Europe may not be entirely accurate. Doing business across Europe is complex, and that alone has slowed market growth not only for Europeans, but Americans and Japanese alike.

Perhaps the biggest impediment to the spread of ASICs is a small user community, according to Forte. "We need bigger users to drive the technology," he says. That may be true. The key technology driver in the United States is the computer industry, which in Europe contributes only a modest portion of the total market for ASICs. In Europe, the telecommunications market is far larger than the computer industry as well as a key technology driver.

The European market has other idiosyncracies. "We find in Europe applications and customers that are as advanced as anywhere else in the world," says LSI's Thomas. But the Europeans have an unshakable reputation for being talkers — then not following up. "One of the unfortunate aspects of the European market is that there are a lot of grandiose plans for tomorrow or the day after," Thomas adds.

Perhaps the toughest barrier to the European market are the country-to-country rules that plague the sale of ASICs — and most anything else in Europe. Many of the troublesome regulations should disappear when the walls come down and a single market is created in 1992.

Despite the inherent difficulties in selling ASICs in Europe, few European manufacturers are shying away. Philips' Hagmeister explains: "ASICs are a necessity, a fact of life. We have been in the ASICs market, we will be in the ASICs market — no matter what." ☐

Board makers fight for profits as growth slows

As capital equipment costs squeeze vendors, sluggish sales are forecast. Buyers are demanding higher density packaging, improved quality and faster turnaround

BY ROBERT HAAVIND

Despite healthy growth in the U.S. printed wiring board industry — up 17% in 1988 to $5.5 billion — profits have been scarce. For 1989, analysts forecast only slight single-digit growth.

Electronic equipment makers are pressing for higher density packaging with more board layers, often based on surface-mount or other advanced technologies — while at the same time demanding higher quality and faster turnaround to meet the needs of just-in-time production systems. Buying on price alone is also fading, vendors agree, as the big customers seek partnerships with suppliers.

Offsetting the single-digit growth projections, however, is market growth resulting from the shift away from in-house production by systems firms. This is attributed mainly to the high cost of specialized equipment. Captive production has dropped from more than 51% in 1980 to about 38% in 1988, says James Griffin, director for marketing programs at printed circuit board manufacturer Hadco Corp. of Salem, N.H. Griffin says Northern Telecom Ltd.'s recent decision to shut down a PCB facility in Canada is indicative of this trend.

To meet stepped-up requirements, independent manufacturers have been forced to invest heavily in new capital equipment, which has eroded profits. Some of them have been forced to sell off or close some of their less efficient shops as well.

Competition remains fierce in this fractionated market, with the top 10 independents getting only about 25% of the noncaptive business, according to Harvey Miller, president of K-MA Marketbase Services, Palo Alto, Calif. Hundreds of vendors, down to small prototyping shops, along with captive firms such as Tektronix Inc. that do some outside work, get the rest of the merchant market.

Many PCB manufacturers are narrowing their focus, in both products offered and industries served. Meanwhile, many outdated shops are being shut down. Tyco Laboratories, for example, recently closed a two-sided board shop. With growth tapering off in the second half of this year as the computer business slows down, the going is expected to get even tougher.

Market growth for rigid PCBs will drop to 2% to 3% this year after its 17% growth in 1988, according to Bill Loeb of Wm. E. Loeb & Associates, Soquel, Calif., who, together with Henderson Ventures, publishes the newsletter *PCI Report*. Loeb believes that this splintered market of small, often privately held firms, with high capital requirements, may present a tantalizing target to much better capitalized Japanese companies.

Captive PCB production has dropped from 51% to 38% between 1980 and 1988

Loeb points out that the Japanese market reached $5.4 billion in 1988, and should exceed sales in the U.S. market in 1990. CMK, the largest Japanese independent producer, is already establishing a plant to print and etch single-sided boards in San Diego, reportedly to serve Japanese auto and consumer electronics plants in the United States. But since CMK's 1989 sales are estimated at $400 million — over double the largest U.S. independent, Hadco's $157 million — CMK could become a formidable competitor in the U.S. marketplace, Loeb suggests.

Still, the need for closer liaison between systems firms and board makers, coupled with exchange rate pressures, is bringing more printed wiring board fabrication back to the United States. Seagate Technology Inc. of Scotts Valley, Calif., among others, recently moved some board fabrication back onshore from the Far East, according to Jon Kropper, Hadco president and CEO. The trend is toward more North American production, including Canada and Mexico, points out K-MA's Miller.

Hadco's Kropper says factors helping the U.S. PCB business are increased orders for smaller lots of more specialized boards, JIT systems, and the improved service offered by U.S. companies. More automated production raises productivity, particularly for surface-mount boards, and lower labor cost differentials are also helping U.S. vendors.

"Korean wages are now 20 times higher than their 1979 level," Kropper says. He also cites higher wages in Singapore and Taiwan, and exchange rate fluctuations that make Korea and Taiwan less attractive. "But still, American firms must be world class and customer driven to compete," he says.

Clyde Coombs, marketing manager, Printed Circuits Division, Hewlett-Packard Co., and author of the *Printed Circuits Handbook*, shares this sentiment: "There are world-class operations in Korea, Hong Kong, and Taiwan, and you can jump on a plane and be over there in a few hours." However, Coombs emphasizes that these facilities are primarily for very high volume, low-cost production, ideal for consumer products but not for instruments or industrial equipment. The need for local content for overseas markets drives some of the offshore buying, explains Digital Equipment Corp.'s Duane Napp, high performance system manufacturing engineering manager, Marlborough, Mass. About 80% to 90% of boards with up to four layers are being made offshore, says Napp.

There is a major push for surface mount technology for higher connection density, which provides shorter circuit paths for faster computers. SMT also promises improvements in productivity. Automated SMT equipment lowers assembly costs for volume production, and also increases reliability. Until recently, surface mount components cost more than through-hole packages, and selection was limited. Now, Coombs says, they are roughly equal in cost, more SMT parts are available, and they are expected to become cheaper than through-hole devices.

This trend, as with many other advances in printed wiring technology, came out of the consumer business. Sony Corp. was an early user of SMT, for example, for its Walkman. Reliability is not so critical in consumer items, which provide a testing ground for lower-cost, high-volume fabrication technology. However, failure levels in the early phases of innovative packaging would be unacceptable in computers, says Napp.

Until the mid-1970s, IC chips were the limiting factor in switching speed, but since then, wiring lengths have become critical. More layers as well as denser wiring on each layer help shorten circuit paths, so that today's boards are three or four times denser than those in the mid-70s. With pin-through-hole components, some 60% of the component area is wasted, says Napp.

In the U.S., most boards are now in the five- to seven-layer range, according to David Verbeten, director for product management for Norplex Oak Inc., a subsidiary of Allied-Signal Corp., in La Crosse, Wis., which manufacturers copper-clad laminates. Nine-layer boards are now about 15% of the business, Verbeten says. HP has moved from all through-hole production to more than 50% surface mount for new products in the past five years, according to Coombs, and the trend will continue.

But denser circuitry and surface-mount technology offer new challenges to the industry. Pins through holes added stiffness to a PC board that is lost when components are attached only with solder bumps on the surface. More layers help add stiffness, which is important because flexing could break connections in the via holes.

As big board users look to partnering with suppliers, growing vendors are those offering the latest equipment and extended skills and services. Newer firms such as Apple Computer Inc., Compaq Computer Corp. and Sun Microsystems Inc. see themselves as being in the systems rather than the manufacturing business, and they make none of their own boards, according to Hadco's Kropper. They want their suppliers to help them speed products to market, so board makers such as Hadco are now adding or expanding workstation capabilities for advanced in-board design.

Recent growth in the military end of the market has slowed and is expected to be flat through 1990, says Dale Reed, marketing manager for the Soladyne Division of Rogers Corp., San Diego. The market has reached $200 million for PTFE (polytetrafluorethylene, or Teflon) boards for high reliability, mostly microwave applications. Of the less than 20% of that market available to independents, Soladyne has about 40%, says Reed. After 1990 Reed expects the market to grow again at a 4% to 5% rate.

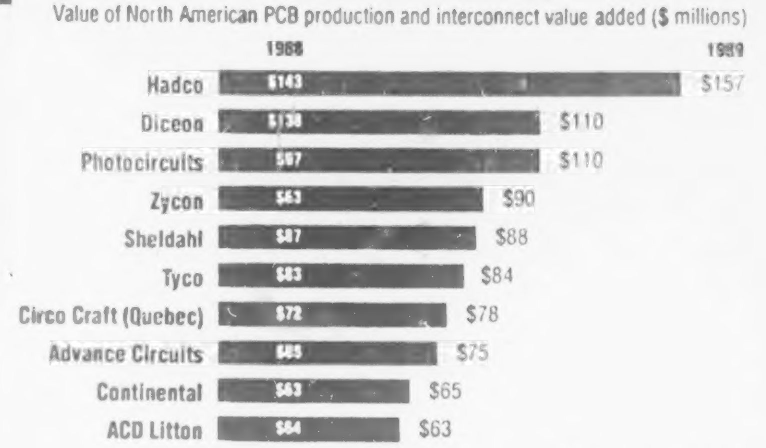
Business is also growing in the Far East. Norplex Oak has gained 45% of the market in Southeast Asia, although only 4% in Japan, according to Verbeten. Although the Japanese share seems small, he says it has doubled each year for the past three years and the company expects significant future growth there. "To succeed in Japan you have to beat their domestic quality levels and have enough capacity to sustain a long-term commitment," he observes.

As factors limiting performance have shifted from chips to interconnections, the industry is pressed to push interconnection capabilities along with semiconductor technology. As chip passivation techniques have improved, several bare chip packaging methods have developed, especially multichip modules (MCMs). IBM launched this concept in the mid-1970s with temperature control modules (TCMs), putting IC chips on ceramic substrates and packaging them with massive cooling structures.

MCM demand will not begin growing rapidly until about 1995, concludes George Messner, senior scientist of PCK Technology, in Melville, N.Y., who has analyzed its potential. Even then, although MCM may grow to be 18% of the total interconnection substrate market, he expects little impact on the conventional printed wiring board business, which he expects to grow worldwide at about 10% a year from $20 billion in 1990 to some $50 billion in the year 2000. ☐

Top Independent North American PCB makers

Value of North American PCB production and interconnect value added ($ millions)

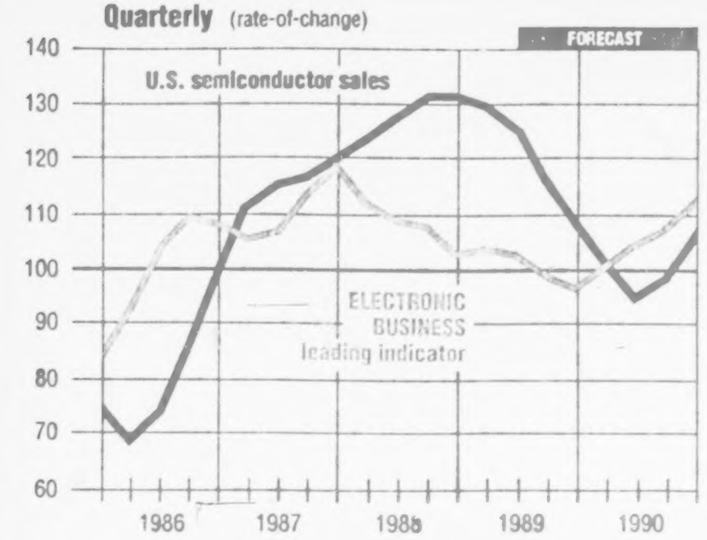


Source K MA Marketbase Services

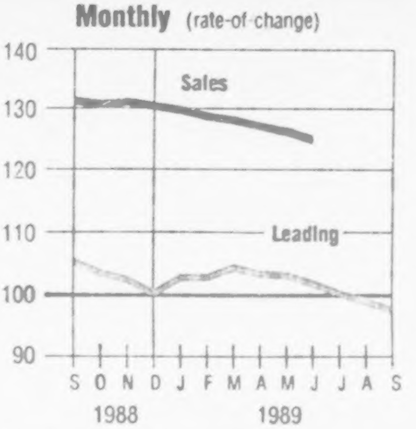
BUSINESS BAROMETER

FORECASTS FOR ELECTRONICS, COMPUTERS AND SYSTEMS

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass. 02158, or call (617) 558-4368



The ELECTRONIC BUSINESS leading indicator dropped to 103.2 in May, down slightly from 103.8 in April. The indicator is expected to reach a low point of 95.7 in October 1989. The bottoming out of the indicator at this level implies that the 1989 slowdown will be much milder than the recession of 1985. when the indicator fell to 80.8 in October 1985.

Source: Cahners Economics

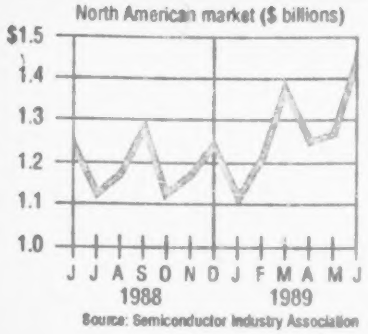
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, May)	103.2	103	108.5	107.6
U.S. semiconductor bookings ($ millions, 3-month average, June)	$1,307	$1,286	$1,287	$1,178
Weekly hours of semiconductor production workers (monthly average, May)	39.4	40.0	40.2	40.2
Electronic components leadtime index (1977 = 100, July)	107.4	120.6	123.2	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, June)	57.6	55.9	64.6	54.5
Change in electronic components inventories ($ millions, SA, May)	+$22	+$16	-$12	+$80
Contracts and orders for plant and equipment ($ billions, SA, May)	$41.6	$44.5	$36.0	$39.4

SA = seasonally adjusted, all other data is not seasonally adjusted

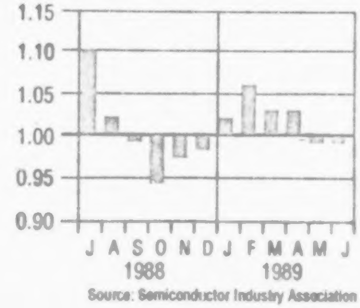
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



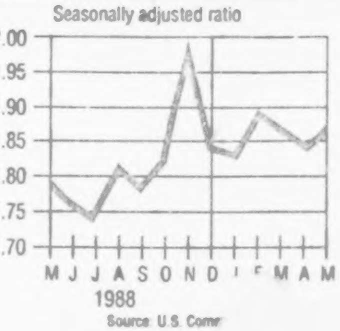
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



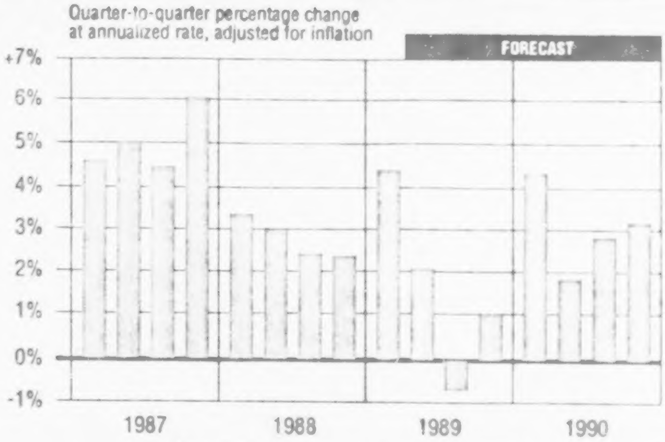
Source: U.S. Comm

Cahners Economics forecasts

Percentage change	February forecast 1989	February forecast 1990	July forecast 1989	July forecast 1990
Real GNP	+2.7%	+1.7%	+2.6%	+1.5%
Consumer price index	+4.7%	+4.7%	+5.1%	+4.7%
Industrial output	+3.3%	+1.7%	+3.2%	+1.4%
Disposable income	+2.6%	+1.7%	+3.4%	+1.6%
Business investment	+4.9%	+2.0%	+4.5%	+2.3%
Pretax profits	+3.1%	+1.6%	+1.1%	+0.5%

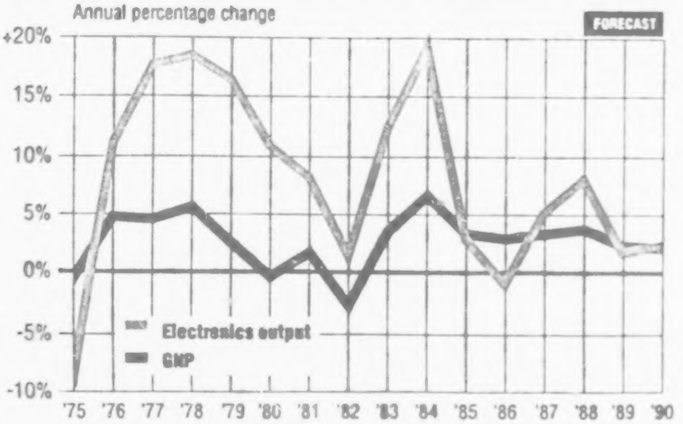
Data source: Cahners Economics

Gross national product



Data source: U.S. Commerce Department; Forecast: Cahners Economics

GNP versus electronics output



Data sources: U.S. Commerce Department, Federal Reserve Board; Forecast: Cahners Economics

Consensus continues: no recession next year

The word *recession* may be more popular these days in the general business press and in arguments among economists, but according to the Blue Chip Economic Indicator, Sedona, Ariz., the consensus of more than 50 economic forecasters continues to predict a soft landing for the economy. Cahners Economics' macroeconomic forecasts — the underpinning for the electronics industry forecasts that are reported in this column every issue — concur. There will be no full-fledged recession in the next year.

The Blue Chip panel predicts the inflation-adjusted gross national product will rise 2.6% in 1989 and 1.5% in 1990, as of the July survey. That consensus forecast is relatively unchanged from the GNP forecast ELECTRONIC BUSINESS reported March 6.

Some doom-and-gloomers in the economic forecasting community remain. Yet optimistic forecasters outweigh the pessimistic ones, so the consensus looks happy.

Interestingly, of all the Blue Chip forecasters, those who work for the banking and security industries are most worried about a recession. These forecasters are predicting a mere 1.4% gain in GNP next year and only a 1% rise in total U.S. industrial output. The group of crystal-ball gazers we classify as economic consultants is a bit more optimistic. This group expects GNP to increase 1.9% and industrial output 1.3% in 1990.

The last group of forecasters, those who work for manufacturing and retailers, is the happiest lot of all. They expect the GNP to increase 1.9%, the same as the consultants, but they also predict industrial output will see a stronger gain of 2.2%.

Cahners Economics GNP forecasts fall in the latter category of optimism. At 2.4% for 1989, our real GNP growth forecast is eighth from the bottom of the Blue Chip list, ranked top to bottom by strongest to weakest growth. In 1990, our forecast of 2.3% growth places us 10th from the top.

What should you make of all these forecasts? Never fear, whatever business scenario you want to plan for next year, you can probably find a number cruncher to support you. At the very least, electronics companies will continue to take their economic forecasts with a grain of salt. As always, the best will remain prepared for more than one possible economic outcome.

ELIZABETH B. BAATZ

The macroeconomic outlook topic will appear again in March

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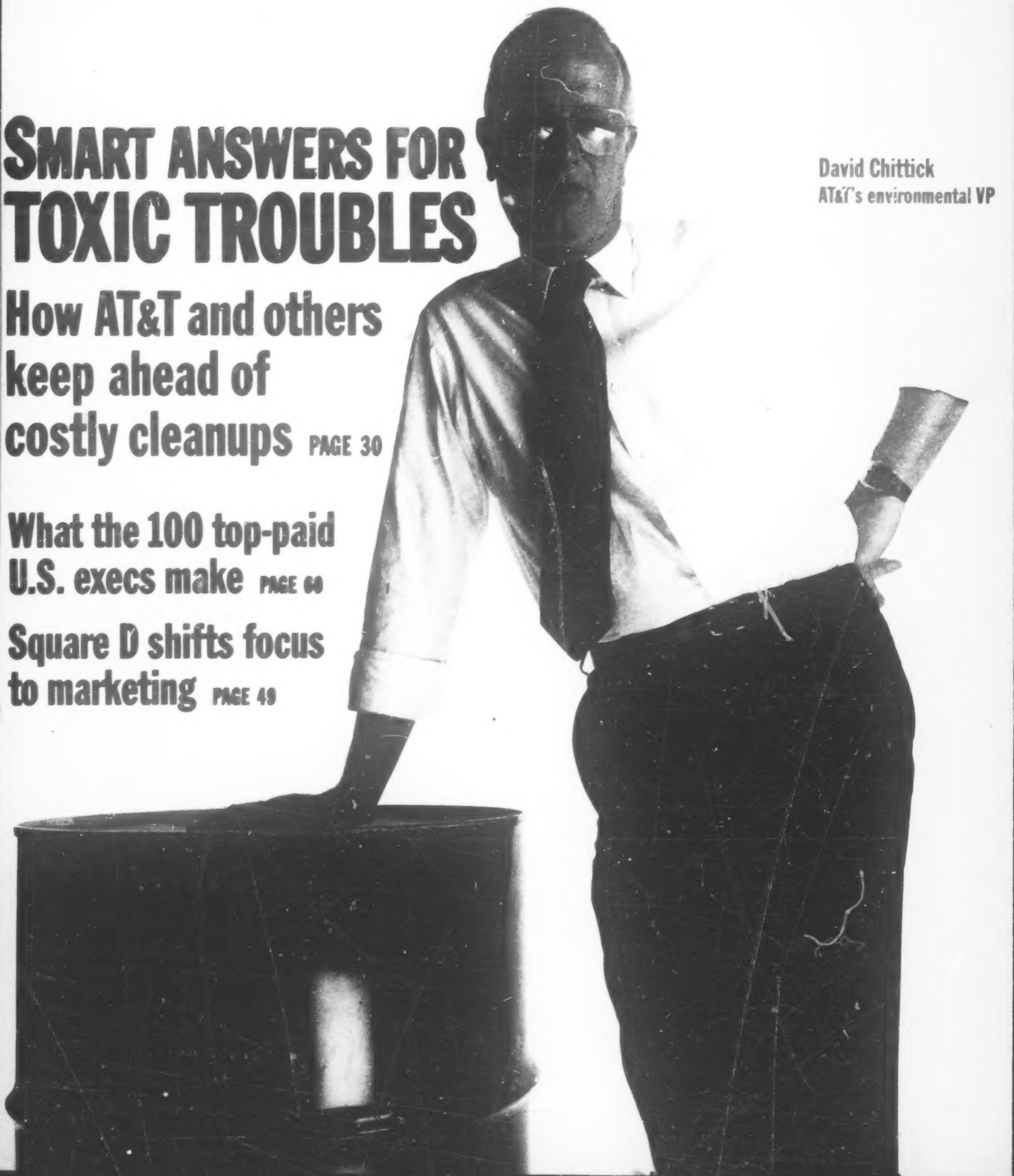
SIX DOLLARS
A CAHNERS PUBLICATION

Electronic Business.

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE
SEPTEMBER 18, 1989



SMART ANSWERS FOR TOXIC TROUBLES

How AT&T and others keep ahead of costly cleanups PAGE 30

What the 100 top-paid U.S. execs make PAGE 60

Square D shifts focus to marketing PAGE 49

David Chittick
AT&T's environmental VP

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES — WORLDWIDE

VOL. 15, NO. 19 SEPTEMBER 18, 1989

PAGE 32 AT&T's environmental vice president David Chittick: "Don't take things for granted. Even the smallest detail can't be overlooked"

COVER STORY/STRATEGIES

30 Smart answers for toxic troubles

It is rapidly becoming clear that environmental issues are being forced far higher on the agenda of electronics management. As the industry loses its pristine image and as vigorous new legislation comes on strong, electronics executives now must make environmental affairs a part of their strategic thinking. Some companies, such as AT&T and Tektronix, are ready. For those that aren't, ELECTRONIC BUSINESS, in this special report, offers a blueprint for action.

BUSINESS TRENDS

17 The amazing, shrinking, flexible fab of the future

The demand for custom chips and the need to cut clean-room costs are challenging the need for megafabs.

22 Rad-hard chips gain in military tactical market

Manufacturers of radiation-hardened semiconductors are looking at the tactical weapons systems market for big opportunities.

ENVIRONMENT

30 Smart answers for toxic troubles

Minding the environment is simply good business. Electronics companies ought to be aware. Driving environmental topics up the agenda are four key factors: thorny new legislation that has the blessing of the Bush administration; public pressure boosted by the Exxon Valdez spill; an international mandate to eliminate by the year 2000 the use of chlorofluorocarbons, and recent court decisions that hold companies responsible for toxics cleanup.

32 AT&T's big push to stay ahead of environmental woes

AT&T has publicly proclaimed it will eliminate all CFC emissions from its manufacturing processes by 1994. But the complete eradication of CFCs certainly will be difficult and may well be an unattainable goal. Clearly, AT&T is putting its reputation on the line before the public, environmentalists and lawmakers.

40 Tektronix on toxics: Looking good by using less

Putting nature first is second nature at Tektronix. The Beaverton, Ore., test and measurement company's reactions to environmental issues are pure reflex, where protecting Mother Earth with techniques that minimize toxics makes good business sense as well.

42 Sound environmental practices add to bottom line

From board makers to defense contractors, large and small, the solutions offered for cleaning up are innovative and dramatic. ELECTRONIC BUSINESS culls the most compelling examples of environmental management in action.

STRATEGIES

49 New culture at Square D puts the focus on marketing

With energetic captain Jerre L. Stead at the helm, the once-staid electrical equipment maker is undergoing a "huge culture change" — moving aggressively to expand sales vertically and overseas. Stead's aim is to grab market share away from competitors in the industrial sector in programmable logic controllers and a host of automation, power and distribution equipment as well.

MANAGING RESOURCES

60 Top bosses' pay slows in sluggish electronics sector

The superstars of the executive suite barely kept pace with inflation in 1988, while the rank and file of electronics executives managed to keep moving ahead. Apple's John Sculley again tops the ELECTRONIC BUSINESS list of the 100 highest-paid U.S. executives. Sculley made nearly $2.5 million in salary and bonuses last year.

PAGE 49 Square D chairman Jerre L. Stead: "For the first time, we'll be focused on a market and not a product orientation, or on technology"

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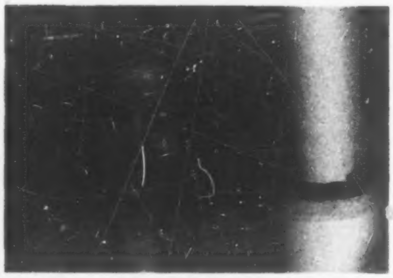
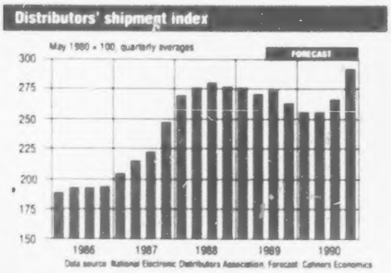
NEURONS

PAGE 79 The expanding neural marketplace challenges Japanese engineers



PAGE 40 Tektronix's Theresa Parrone: Cut emissions by using fewer toxics



PAGE 113 Business Barometer: Rumblings of the slowdown

PAGE 85 Hadco's Jon Kropper: Pushing PCB equipment makers to enhance capabilities

PAGE 17 Lasarray's Tim Fitzgibbons: The shrinking, flexible fab of the future

EUROPE BUSINESS

73 European auto market beckons chip producers

The global auto market has become increasingly important to semiconductor producers. But if chip makers have been depressed by a U.S. car market that is stuck in neutral, they should look eastward to Europe, where sales are zooming along in overdrive. Add increasing sales to new emissions rules for European Community nations and there's a bonanza to be had.

ASIA/PACIFIC BUSINESS

79 Expanding neural marketplace challenges Japanese engineers

In engineering labs across Japan, scientists are turning increasingly to chemistry and biology to create new designs for neural network computer systems. Customers of at least one Japanese company — NEC — are using neural network systems in personal computers. These are used primarily in research and development environments to further work in pattern recognition, expert systems, movement control and signal processing.

MARKET PERSPECTIVES

85 Users push board makers to enhance equipment capabilities

While the business of fabricating printed circuit boards is forecast to rise a mere 1% to 2% this year after a banner year in 1988, companies that fabricate and stuff boards are spending heavily on new capital equipment to stay competitive in a demanding marketplace. Vendors that come up with new concepts to meet the challenges are finding eager buyers, both in the United States and overseas.

CONTRACT MANUFACTURING

91 Contract service outfits' revenue keeps booming

There just seems to be no stopping the growth of companies that find their niche in helping design, manufacture and test the electronics of others. Despite doldrums in some parts of the electronics industry, these concerns just keep on keeping on. The 114 firms responding to the ELECTRONIC BUSINESS survey for the 1989 Contract Manufacturing Directory say they are on track for significant revenue growth this year compared with 1988.

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For distributors, the rumblings of slowdown have suddenly blasted loud and clear through the bullhorn called bookings.

114 **Components**
Like other electronic markets, components manufacturers have also succumbed to an economic slowdown.

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Smart marketing. And the dumb car

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Say goodbye to the "mom and pop" chip fabs?

COMPANIES IN THIS ISSUE

100 **An index of the companies covered in this issue.**

Welcome to the team

Jim Asker, managing editor

A few issues ago, we announced on this page Jeff Bairstow's appointment as editor. During the intervening months, we at ELECTRONIC BUSINESS have taken some very definite steps aimed at continuing our magazine's tradition of quality. One of those is the selection of Jim Asker as managing editor/editorial.

We are lucky to get Jim. He brings in more than 15 years as a reporter, writer and editor. Most recently, Jim was a Boston-based free-lancer, writing about science and technology.

Most of Jim's career has been spent in Texas. He joined *The Houston Post* after graduating from Rice University, where he studied economics, applied math and history. He made his mark at *The Post* covering the space program, breaking some big stories following the Challenger disaster. Jim's work landed him a finalist spot in the Journalist in Space program. He was one of 40 Americans selected from 1,700 journalists who applied to be the first to fly aboard the shuttle. Jim came to Boston as a Knight Science Journalism Fellow at the Massachusetts Institute of Technology — studying for a year at MIT and Harvard.

Jim's background will be a boon to us. Surely, he has the technical credentials that gives him insight into electronics. But since we're also in the journalism business, a newspaperman's mentality won't hurt either. Jim's primary responsibility will be to oversee the reporting and writing of our talented and far-flung editorial staff. Welcome to the team.

Quality issue; automation award

- When the mail arrives Oct. 2, your issue of ELECTRONIC BUSINESS won't be in the stack. That's because we've decided to marshal our editorial energies toward producing a blockbuster Oct. 16 issue that will focus entirely on the issue of quality in the electronics industry. Our special issue is a prelude to the announcement of winners of the second annual Malcolm Baldrige National Quality Award. We'll offer a fresh and detailed examination of quality and American competitiveness.
- In our March 6 issue this year, Texas Instruments Inc. was announced as the recipient of our annual "Electronics Factory Automation Award," recognizing its circuit-board facility in Johnson City, Tenn., as the outstanding example of automation in action. We'll make another award in early 1990 and are seeking entries. The entry deadline: Nov. 3. For entry information, call Susan Parziale of our staff at 617-558-4621.

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BPA ABP

Rad-hard chips gain in military tactical market

As space and strategic systems fly high with radiation-hardened chips, the tactical market is poised to take off

When the U.S. Department of Defense shifted its nuclear policy in the early part of the decade from a strategy of mutually assured destruction to one of survival through use of tactical systems, electronics-equipment manufacturers lacked the technology to meet its standards.

Now, electronics is catching up. Until 1983, lead shielding was almost the only protection for sophisticated electronics. Today, advances in semiconductor-process technology have resulted in chips that can withstand ever higher levels of radiation, and this means big opportunities for military chip makers. As a result, the DOD is requiring that battlefield equipment function during and after a nuclear exchange.

Right now, the dollar volume for the tactical rad-hard semiconductor market is still negligible. But this market segment is about to take off. Most of the low-cost chips are either in the process of DOD qualification or the manufacturer is still bringing product to market.

Staggering military market

Why the sudden interest in tactical applications? The potential is staggering. The total worldwide military demand for semiconductors is estimated at about $2 billion — $400 million for space and strategic systems and $1.6 billion for tactical systems. Dataquest Inc., a San Jose market-research firm, estimated the total North American rad-hard market at about $330 million in 1988, with a growth rate of 24% each year over the next three years.

That $330 million was spent almost exclusively on satellites, strategic-weapons systems and the Strategic Defense Initiative program, where expensive and exotic technologies — gallium arsenide, silicon on sapphire, and silicon on insulator — are standard fare.

What is more exciting to companies is the $1.6 billion tactical market. While the total tactical-semiconductor market is estimated to be growing only about 5% a year, market observers have the radiation-hardened and radiation-tolerant portion posting anywhere from 7% to 20% annual growth.

"There appears to be a void as far as serving the tactical market," says Dick McCoy, product-line manager for semiconductor products at United Technologies Microelectronics Center (UTMC) in Colorado Springs, a manufacturer of semicustom and military-standard very large-scale integration chips. Defense contractors typically either buy exotic technologies, or they pick up non-rad-hard parts and then try to qualify those themselves.

Aggressive marketing

UTMC is aggressively trying to capture a chunk of the rad-hard market with its new line of application-specific integrated circuits. It is taking its high-end rad-hard chips that go into space and strategic systems and selling them at a lower price into the tactical market.

North American rad-hard semiconductor production

($ millions)

ICs	1987	1992
Standard logic/PLD	$37.1	$66.7
ASICs	46.7	156.1
Microcomponents	31.8	111.3
Memory	47.6	121.6
Linear	63.9	143.0
Total ICs	$227.1	$598.8
Discretes	$34.7	$70.0
Optoelectronics	$8.9	$18.8
Total rad-hard semiconductors	$270.7	$687.5

Source: Dataquest Inc

Even with expected budget trimming, military retrofits, upgrades and designed-in applications all hold promise for rad-hard chip makers

"We can do so because the amount of testing and the level of assurance is lower in the tactical marketplace," says Jim Adams, UTMC's director of strategic planning. The cost of testing in the strategic marketplace is astounding. According to one independent source, testing for space qualification can run from $10,000 to $100,000 per device type.

UTMC is not alone in its bid for tactical business. Harris Semiconductor, a sector of Harris Corp. in Melbourne, Fla., is in the process of introducing a whole new line of rad-hard chips aimed at the tactical market. Called the Radiation-Hardened Assurance Program (RHAP), Harris expects to blitz the market with more than 300 types of rad-hard or rad-tolerant chips before year end, ranging from metal-oxide semiconductor field transmitters (MOSFETs) to microprocessors to complementary metal-oxide semiconductor logic chips.

"We have taken what we learned in space and applied it to the general-purpose JAN B products," a joint Army-Navy specification system, says Bob G. Quinn, vice president for strategic marketing for Harris Semiconductor's military and aerospace division.

Harris is the one to watch when it comes to military semiconductors. It is by far the largest supplier, accounting for 10% to 15% of the total U.S. military market. With its acquisition of General Electric Solid State in Somerville, N.J., last December and with other acquisitions reportedly in the making, that position is strengthening.

Other companies are eyeing the market, too, including Texas Instruments Inc. in Dallas, National Semiconductor Corp. in Santa Clara, Calif., and LSI Logic Corp. in Milpitas, Calif. All are keeping tabs on the tactical arena while continuing to focus on the space and strategic business. "We are seeing radiation-tolerant requirements being placed on tactical weapons," says Thomas Smith, TI's business development manager for military products.

National's Steve Kelley, marketing manager for military CMOS logic, confirms this. Battlefield equipment used in the European theater is particularly vulnerable due to the high number of tactical nuclear weapons, he says. National's Fairchild advanced-

CMOS technology (FACT) family of logic chips has one of the higher radiation-tolerance levels on the market. Currently, most applications are in the space and strategic market, but National is also incorporating the FACT devices into the head-up display for the Air Force's advanced tactical fighter (ATF), Kelley says.

An added boon to the rad-hard market came in April. The DOD eased its chip export regulations in an effort to help U.S. chip makers recover lost market share and improve their global competitiveness.

Part of the reason the tactical market is enjoying increased appeal is that SDI and other strategic programs could face serious budget cuts as the defense budget is trimmed to meet the Gramm-Rudman budget-reduction law. Many tactical-weapons systems and the chip makers that supply them will benefit from the budget cut, because retrofits and upgrades will become more common.

For instance, the F-16, the multirole fighter made by General Dynamics Corp. in St. Louis, is said to be scheduled for radiation hardening around 1991. The same goes for the Navy's F-14Ds and the Army's M-1 tank. In fact, a number of leading chip makers foresee the retrofit market as providing the biggest part of the tactical rad-hard business. "We are pretty bullish because of retrofits," says Marybeth Rotermund, director of military-aerospace marketing at LSI Logic. She expects 10% to 15% growth in the tactical rad-hard market for ASICs.

Still, new defense programs with designed-in rad-hard chips also hold promise. About 40% of new programs are incorporating some degree of radiation hardening, TI's Smith says. These reportedly include such major buys as the ATF; the Navy's advanced tactical aircraft (ATA); the advanced medium-range air-to-air missile (AMRAAM); the army's fiber-optic guided missile (FOG-M); the single-channel ground and airborne radio system (SINGARS); the advanced anti-armor weapon system — medium (AAWS-M), and the search-and-destroy armor (SADARM) missile.

BRUCE C.P. RAYNER

What's a radiation-hardened semiconductor?

There is some confusion as to the definition of a radiation-hardened semiconductor. Some firms spend millions to develop exotic materials and technologies specifically to withstand high levels of radiation. Then, others claim they make rad-hard chips for military use, but in reality there is nothing fundamentally different between their commercial and military products. Can both claim rad hardness?

Simply put, no. Rad hard refers to a designed-in requirement by the customer — usually the military — and it means a fairly high level of radiation protection. The term radiation tolerant, on the other hand, is commonly applied to chips that have some intrinsic hardness, but have not been developed specifically with rad hardness in mind. Both have a place in the military's demand for semiconductors.

In 1983, the DOD issued a directive calling on the armed services to specify radiation-hardened or tolerant semiconductors in their designs of tactical-weapons systems. In July 1988, an update was issued, additionally requiring that certain existing systems be retrofitted with rad-hardened chips.

Generally, electronics must be protected against four types of radiation: total dose, single-event upset (SEU), neutron effect and dose rate. Spacecraft, satellites and strategic systems must be shielded from all four types of radiation. Satellite systems, for example, have to be protected against long-term radiation (total dose and SEU) from the Van Allen belts and the sun. Tactical-weapons systems, such as fighter planes, ships, submarines, ground-based computers, communications equipment and other command and control equipment, need only be guarded against fallout from nuclear explosion (neutron effect and dose rate).

Rad hard refers to a designed-in requirement by the customer — usually the military

Space and strategic applications are by far the more demanding when it comes to radiation hardening, requiring protection on the order of 100 kilorads. (A rad is the basic unit of measure for the absorption of ionized radiation.) This is the realm of gallium arsenide, silicon on sapphire, and silicon on insulator. Tactical weapons, on the other hand, require between 10 to 20 kilorads of protection. Yet they tend to be much more cost sensitive because of the high volumes of chips involved.

Chips used in space and strategic applications have to satisfy strict testing and assurance requirements, known as JAN S for joint Army-Navy, level S. Tactical chips have to comply with JAN B, which is less stringent. Neither fully qualified JAN B nor JAN S products are allowed to be made offshore. Much of the cost difference between JAN S and JAN B is in the testing.

In some weapons systems, the line between strategic and tactical is starting to blur, since the long-term effect from exposure to radiation is important for tactical systems as well. The DOD wants equipment that will be reusable after a nuclear exchange. It also wants weapons systems, such as the cruise missile, that can withstand long exposure and still function.

The DOD has set stringent requirements for assurance and testing for both space and tactical electronics. It has also designated four levels of radiation hardness called the Radiation Hardness Assurance (RHA) categories that defines the integrity of the part the semiconductor maker must guarantee for any particular rating. However, specific weapon systems set their own rad-hardness based on the perceived threat and function of the system. Most of these specifications are classified. ☐

New culture at Square D puts the focus on marketing

With an energetic captain at the helm, the once-staid electrical equipment maker is moving aggressively to expand sales vertically and overseas

BY BARBARA N. BERKMAN

Flush with energy — his daily 6-mile run starts at 5:30 in the morning — Jerre L. Stead is on the road again. During the two years since he assumed leadership of Square D Co., Stead estimates he has spent 40% of his time delivering a single message to customers, distributors and Wall Street: Square D has been reborn.

For years, Square D has profitably turned out switches, relays, control products, and power and distribution equipment, largely for the residential and construction markets. But in the 1980s, earnings growth slowed. A Swiss army knife of electrical suppliers, selling everything from copper foil to home automation systems, Square D burdened itself by marketing 18,000 items to several diverse markets. The $1.7 billion company left itself open to cyclical swings by becoming dependent on the construction industry for 53% of worldwide sales.

Now, aided by what Stead calls "a huge culture change," Square D is moving aggressively toward increasing sales to industry and overseas. Chairman Stead's strategy: downsize, and restructure Square D's organization and sales network along vertical markets and increase selling and administrative expenses to 22% of sales. His aim is to take market share away from competitors in the industrial sector in programmable logic controllers (PLCs) and a host of automation, power and distribution equipment as well.

The cornerstone of Square D's cultural awakening is marketing. The Palatine, Ill., company never has made an effort to sell the industrial original equipment manufacturers its total product line. But in June, Stead restructured Square D along three vertical markets: industrial, construction and international. "For the first time, we'll be focused on a market and not a product orientation, or on technology. It will allow us to be much more focused," says the former Honeywell Inc. vice president. "We've never gone in and sold that total package of capability [across product lines] to the customer."

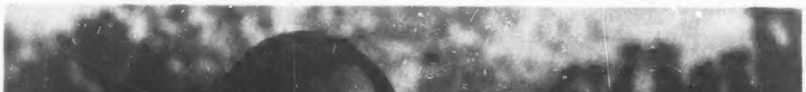
Stead is executing a strategy he inherited from Dalton Knauss, Square D's recently retired chairman who became the company's president in 1984 and hand-picked Stead to be his successor. The 46-year-old Stead took over as president in 1987 and as chief executive and chairman earlier this year.

New operating, financial goals

Since then, Stead has introduced a new set of operating and financial objectives. To meet those goals, he also incited cultural change. A believer in teamwork and "self-directed work forces," his management style is "driving decision making and authority far down into the organization."

Says Stead, "I don't believe in policy and bureaucracy, because people hide behind them."

The new discipline is already show-



Square D chairman Jerre L. Stead: "For the first time, we'll be focused on a market and not a product orientation, or on technology"

ing up in improved earnings. Sales in the first half of this year increased 10.9% to $885.7 million from $798.9 million during the same period a year earlier. Still, net earnings rose only 2.2% to $59.8 million, in part because of a stock buy-back program.

That's a big jump over 1987, when Square D's electronic products group had an operating loss of $6.6 million after a restructuring charge. The company is moving away from electronic products, whose earnings have lagged behind those from Square D's core electrical business.

Revenue from electronic products, including PLCs, copper foil, semiconductors, power conditioning equipment, welder controllers and uninterruptible power systems, contributed 17% of the company's 1988 sales. Two electronic product units — copper foil maker Yates Industries and power equipment maker General Semiconductor Industries are being sold. To strengthen its position in PLCs, Square D bought Crisp Automation Inc., a process control maker, in mid-July.

Ever the marketer, Stead is making sure Wall Street takes notice. "He is getting the word out about how much the company has changed, judging by the stock price," says Robert Cornell, an analyst with Shearson Lehman Hutton Inc.

On Wall Street and within Square D, Stead is a natural communicator. His answers often are prefaced by the phrase, "That's a good question" —a speaking mannerism that encourages inquisitiveness, particularly from Square D employees. "I am a great believer in role models for making change happen, so I like to spend time with people," he says.

Vision College

To further communicate his goals to his work force, Stead is providing the opportunity for all employees to attend Vision College, a two-day session that drums in Square D's 24 "vision" principles. Stead claims to have answered personally more than 3,500 letters to Ask the President, an internal-communication program linking him to the trenches. Other forums: quarterly communication videos to all operations; routine informal lunches with no more than 10 employees whose birthdays fall during that month; "fireside" chats with a handful of managers; and spending 60% of his time visiting operations, delivering a 20-minute speech, then fielding employees' questions.

Ever the marketer, Stead is making sure Wall Street takes notice

This type of corporate chitchat is new to Square D, says Stead. "We were a company where you weren't allowed to ask anyone about anything."

The openness has produced a wealth of exchanged ideas, according to sales staff. "The cultural change is working with the majority of people," says one field sales representative. Yet, he mentions, some of the old-timer marketing and sales staff find the transition difficult. "This new enlightenment about how to do business — it's almost insulting to be told this is miracle stuff."

One major change is that Stead has overhauled the sales incentive system to eliminate the unprofitable sale driven by volume. "People were paid on volume sales," says another sales rep. "When they couldn't afford the time, they could always go to the commercial sale for volume." Says corporate account manager Bill Matthaei, "The focus is on the customer instead of getting the order. I don't feel the pressure to get high volume."

There's still some grumbling about accepting new sales practices, particularly Square D's push to keep prices stable. One account manager claims Square D balks at shaving 2% or 3% off the price of power equipment. Not true, says Stead. "We shave up to 15% off prices every day of the week," he claims, adding that the company has "worked hard to bring prices in power equipment up."

Another sour point is that Square D has been slow to apply resources

Square D at a glance

	1988	1987	Change
Sales ($ millions)	$1,657	$1,484	+11.6%
Net income ($ millions)	$119	$110	+8.1%
Net income/ sales	7.2%	7.4%	—
Cost of sales/sales	66.8%	64.8%	—
R&D/sales	3.0%	3.0%	—
Marketing, G&A/sales	21.6%	20.8%	—
Number of employees	20,700	19,800	+4.5%
Sales per employee	$80,037	$74,961	+6.8%
Net income per employee	$5,746	$5,556	+3.4%
Capital expenditures/sale	5.1%	2.9%	—
Current ratio	1.57	1.71	—
Debt/equity ratio	0.44	0.36	—
Foreign sales/sales	19.8%	19.0%	—

All figures for fiscal year ending December 31

Source: Company reports

to form partnerships with other companies. "Our most significant challenge is to develop partnering methods to allow us to increase our visibility in front of the customer," says a Square D account manager. Stead responds that Square D formed 21 partnerships over a recent 16-month period.

Internal changes

Though not altogether visible to customers, the new era has had profound internal effects on Square D.

First is the effect of change itself. More than half of the company's 50 senior managers are outsiders, as are half of the sales managers in the Automation Products group. Accompanying the influx of outsiders, including Stead, has been a score of internal reorganizations. "I would just like a little stability to our own structure," complains one sales rep. "We're sitting here with our hands on our hips, saying, 'What are we trying to do?' You can only do that so long. When you make these changes, the competition grabs at it."

The changes in marketing and sales are sweeping, as Stead chases what he estimates to be a $2 billion global market for PLCs, welding controls and press control applications. He dismantled three organizational levels, as of July leaving three layers between himself and field sales: a sales vice president, 10 regional vice presidents and 91 district managers.

Management fired or retired 100 salespeople from a worldwide force of 1,600 and added 300 newcomers. Companywide, Square D has pared away 10% of its work force and sold off 12 plants since 1986. Square D is allocating 2% of payroll to training, adding role playing for field sales staff, who previously went through a 14-week course on products, pricing, entering orders and "three minutes on how to sell," says Stead.

The advertising and promotion budget leaped to $24.5 million in 1989, up from $16.5 million in 1987. A major expenditure has been revamping Square D's relationships with distributors.

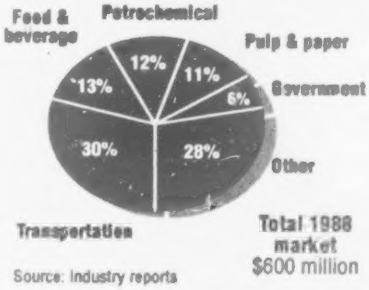
"We had a lot of people who really believed our distributors were our customers. They're not. They're our partners." Asked by distributors for his definition of partner, Stead replied, "We'll share the risks together, and we'll share the rewards together." In May 1988, Square D offered a 1.5% above-margin promotion incentive to distributors who committed to a single line. Stead expected about 400 of the company's 1,200 distributors to join the costly program. A year later, 820 distributors have signed up.

Vertical marketing

Perhaps the major change is the emphasis on vertical marketing. Last year, Stead created Corporate Market Development (CMD), a 40-salesperson section targeting four vertical markets with high capital expenditures: food and beverage, transportation, paper and chemical, and the federal government. By 1993, Stead expects to see $400 million to $500 million of additional business from CMD.

U.S. PLC market

Programmable logic controller market



Source: Industry reports

Square D has begun targeting vertical markets with high capital expenditures: food and beverage, transportation, paper and chemical, and government

To reach the automotive automation market, Square D also added 36 salespeople over the past two years, intending to push its domestic market share over its current 5% to 8%. The company is the industry leader in electronic welder controls, a niche in which Allen-Bradley Co., the company's archrival in automation products, doesn't participate.

The revamped selling program is expensive. Selling, general and administrative expenses edged up 3% since 1985, to 22%. "The 'S' is up more," says Stead. "The 'G&A' is down because we knock down bureaucracy wherever we can."

Square D still faces a future of marketing obstacles. The company is determined to nurture vertical industrial markets, at the same time boosting international sales from 20% of consolidated sales in 1988 to 40% by 1995. All the while, Square D must continue to support its traditional base in construction. Allen-Bradley, in contrast, can concentrate its marketing resources on a relatively limited product line, largely for a single market.

"We are not 100% tied to the industrial market, but almost. Our ability to get to that market is very focused," says J. Tracy O'Rourke, president of Allen-Bradley, the Milwaukee-based industry leader in a global PLC market dominated by Asea Brown Boveri AB, Siemens AG, Lucky Goldstar Group, Westinghouse Electric Corp., AEG AG, Square D and Texas Instruments Inc. Allen-Bradley and Siemens both hold a 24% market share. After Allen-Bradley and Siemens, no player has more than a 12% market share. Square D has an estimated 10% share.

Competitive advantage

But market share isn't Allen-Bradley's only competitive advantage. "In general, we have several times more bodies who can go after the industrial market on any day than Square D does," says O'Rourke.

For example, Allen-Bradley has three people selling PLCs in Houston; Square D has one. The company is outmanned in other vertical markets as well, such as pulp and paper. There, the major challenge is credibility, says corporate account manager Bud Palmer. "They doubt we have a serious commitment," he says. "We had five people at an industry gathering in Atlanta in late June. Allen-Bradley had 20 to 30."

Square D had never been a talented marketer before. Its new emphasis on customer service is an even a stronger departure from the past. "Square D has quality products, but it had not been calling on enough people," says analyst Robert Hedrick of Eppler Guerin & Turner Inc. "New management will go in that direction, and it's getting much better."

Take, for example, John Newton, who for years bought Square D's power distribution equipment, but shunned its PLCs in favor of those from Allen-Bradley and TI. "In switch gear and power distribution. Square D's reputation is good," explains Newton, manager of advanced control systems for the Campbell Soup Co. in Camden, N.J. "But on the PLC side, it is not recognized as an industrial leader."

Despite that conviction and his memory of some quality and service problems with Square D switches, Newton is listening to the company's newly aggressive sales pitch. Campbell is one of 21 food and beverage industry companies Square D's CMD salespeople are wooing as a national account, and "they realize we are an unsatisfied customer," says Newton. "For the first time, they've promised us better service."

Critical test

Square D's new pitch has yet to pass a critical test: luring industrial automation customers away from Allen-Bradley. Square D has a strong market for products such as panel boards and circuit breakers, items Allen-Bradley doesn't offer. But in every vertical market targeted by Square D, it encounters an Allen-Bradley that has been entrenched firmly for years. "Historically, Square D didn't make as good a move into electronics as it should have. It was a laggard in the PLC market," says Shearson analyst Cornell.

But prying away traditional Allen-Bradley PLC customers will be a tough sell, and Square D probably will be successful only with renovated or new plants. Laments one Square D sales rep, "If anyone looked at our capability and support and product in general, we'd have them beat with product. But a lot of plants are so familiar with Allen-Bradley that even if they wanted to, it's difficult to change."

Take General Foods Corp., in transition since its acquisition by Kraft Inc. and therefore an important target for automation products. "We're not sure where the corporation will stand regarding Square D vs. Allen-Bradley," according to Michael McDonald, a project engineer with General Foods in Fulton, N.Y. "The Square D national account manager has said the local reps would follow up on service and quality, and they've done well. They did see this as an opportunity to break the Allen-Bradley tradition."

General Motors Corp. is another targeted national account — one that has been hard to crack. Square D lost out on automating the celebrated Saturn plant, only picking up about $1 million in business for Saturn's electronic welder controls.

"Our people are familiar with the equipment and how it operates," says Thomas Pauli, electrical facilities engineer for GM's Hydro-Matic division, which uses PLCs from Allen-Bradley and Modicon Inc., an AEG subsidiary. "In order for us to change to a new manufacturer, it would require some significant benefits. Square D was just a little late in coming on-line, and it's an uphill battle from now on."

One niche is with customers who use Allen-Bradley's family 2 PLCs, but are resisting the higher prices the manufacturer imposed on the family 2 with the introduction of the later-generation family 5. Some customers are balking at the Hobson's choice of paying a premium for old equipment or paying thousands more on software to make the families work together. "The old programs will not run with the new CPUs and I/Os," says O'Rourke. "Any time that you have a technology change, you are vulnerable to opening the doors to competition."

Can Square D make up for lost time? Maybe, says Allen-Bradley's O'Rourke. "Any time you have the market share we have, you're vulnerable. If Square D is clever enough, they might find some niches." □

Square D is taking a bigger plunge overseas

By the turn of the century, Square D Co. president Jerre L. Stead wants one-half of sales, including those from joint ventures and alliances, to originate overseas. "We don't have the luxury of growing all our business on the continent," he says. But with international sales accounting for only 20% of sales in 1988, Square D will have to make up for lost time.

"In the United Kingdom and Australia, we are strong," says Stead. "After that, in the rest of the world we have a long way to go."

To succeed, Square D is investing heavily; 35% of sales are being plowed into international activities. "Because of aggressive investments, particularly in research and development, margins are 8% to 10% less than in the United States," he says — but improving. "We were convinced we were selling on price," he continues. "We're still paying a penalty for buying share with price. We'll be paying for another year or two."

There have been other missteps. Earnings recently improved in Mexico, a result of Square D shifting its strategy to go after the low end of the market, instead of pushing products with "bells and whistles," explains Stead. In Canada, where Square D has strong market share for several products, Square D bolstered its position by replacing top management and investing heavily in new products. "It was a good business we let get in trouble," says Stead.

Recently, the company consolidated European operations into one headquarters with new management; introduced a series of new products in Europe, where Square D is the No. 2 player in industrial automation; invested heavily in sales and marketing in the Pacific Rim from headquarters in Singapore; and is building a new factory in Thailand, where production will begin in autumn.

To serve Japan, Square D has teamed up with Idec Izumi Corp. for joint marketing, research and product development. More partnerships should follow. "We are looking actively for the right acquisition or joint venture in Europe," says Stead.

Even this strategy may fall short. "It's hard to go completely alone and make it in the global marketplace," says J. Tracy O'Rourke, president of Allen-Bradley Co., the industry leader. "We've been aggressive with that. They're just beginning. It's not just an issue of financial resources." □

Top bosses' pay slows in sluggish electronics sector

Growth in cash compensation for top 100 executives was the slowest in three years, showing basic weakness in the industry

BY BRUCE RAYNER
and LINDA STALLMANN

Granted, it might be hard to take pity on these folks. As members of high tech's upper echelon, every one of the 100 highest-paid executives in the exclusive ELECTRONIC BUSINESS annual salary survey could still swear to be drawing in the upper six figures. Nonetheless, the superstars of the executive suite barely kept pace with inflation in 1988, while the rank and file of electronics executives managed to keep moving ahead.

What's more, parts of this constellation actually began to burn out. The million dollar club shrank, from 17 to 11 members. Even worse, the number of executives in the megabucks who took pay *cuts* last year more than tripled, growing from seven to 22. That is the worst result since the industry's recession year of 1985, when 31 suffered lower pay.

At the top of the list again was 49-year-old John Sculley, Apple Computer Inc.'s chairman, president and chief executive, who made nearly $2.5 million in salary and bonuses last year. His pay was a third higher than that of second-placed Joseph R. "Rod" Canion, president, chief executive and director of Compaq Computer Corp. Sculley has ranked at or near the top of the list since ELECTRONIC BUSINESS began compiling it in 1984. Sculley's pay rose 15.8%, while Canion's 35.8% raise helped move him up from fourth place in 1987.

Still, the average pay increase for the industry's top 100 executives rose by only 4.6% in 1988, significantly slower than pay increases in any year since 1985. Adjusting for inflation, last year's increase was a paltry 0.4%. This slow growth compares unfavorably with the 10% to 14% executive pay growth for industry in general.

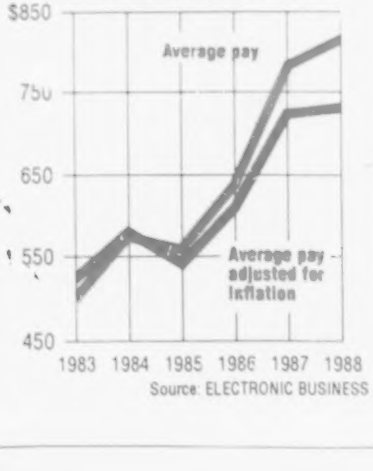
Don't shed too many tears for these men, though. (There are no women, by the way.) These heavy hitters' salaries and bonuses averaged $821,000 in 1988, up from the average of $785,200 in 1987. Information in the listing was culled from proxy statements and interviews at publicly held, U.S.-owned companies doing at least 70% of their business in electronics. The figures do not include the value of stock or stock options.

Ellison: 48th to seventh

Besides Sculley, a top-10 executive with one of the biggest smiles may be Lawrence Ellison, the president and chief executive of Oracle Systems Corp., who rose from 48th place in 1987 to capture the seventh spot in 1988. His pay package nearly doubled from $711,875 to almost $1.4 million. Even more meteoric, however, were the rises of Thomas C. Roberts, executive vice president of Control Data Corp., and Ben Newitt, vice chairman and chief executive of Applied Magnetics Corp., in the 11th and 12th spots, respectively. Neither made the list last year. Roberts, who resigned in late December, almost tripled his pay, bringing in a cool $1 million in 1988; meanwhile, Newitt's base pay of $230,000, with bonuses totaling $999,705, garnered him a 138.6% increase over 1987.

Executive pay

Average salary of the top 100 ($ thousands)



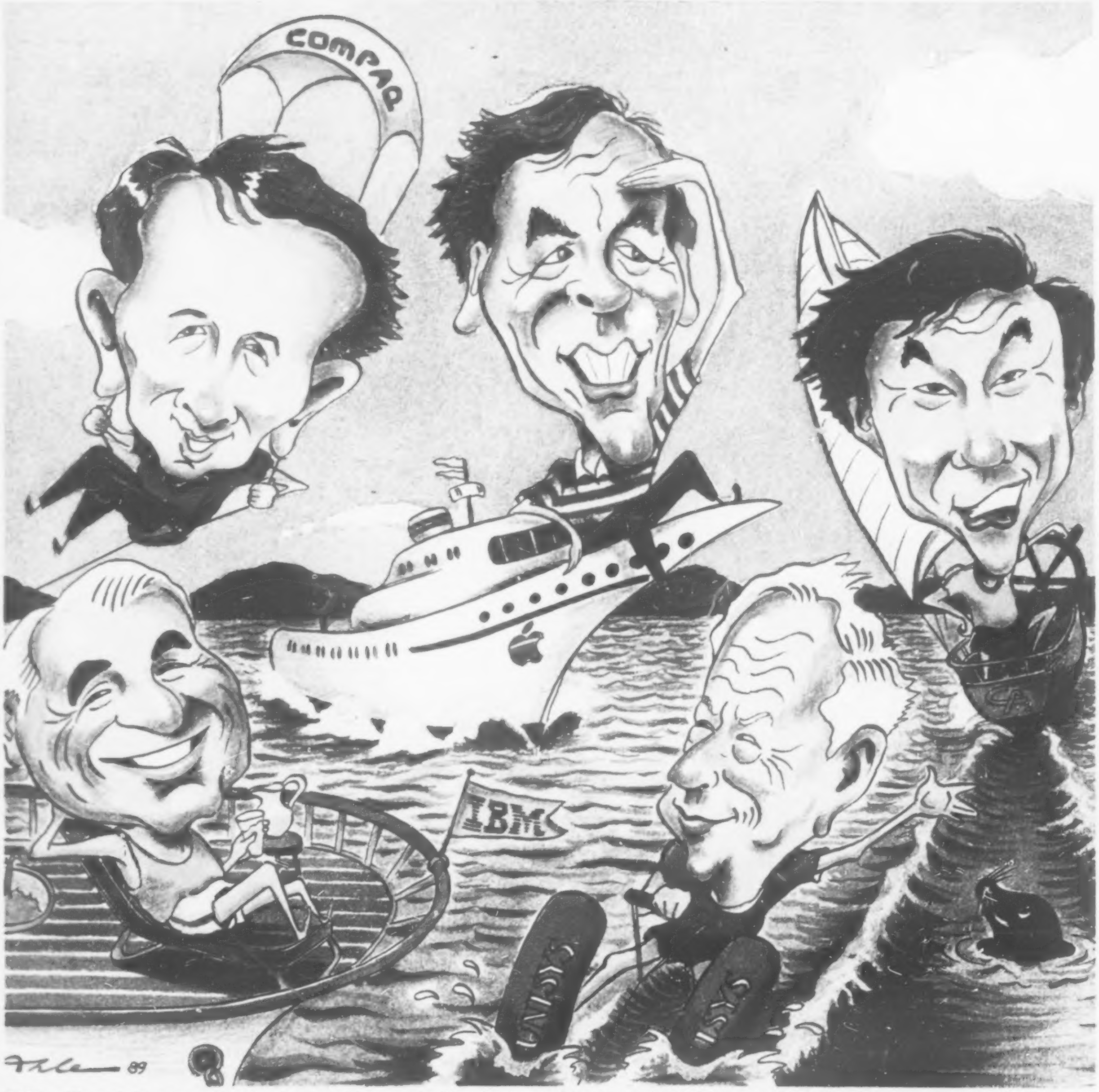
Source: ELECTRONIC BUSINESS

One trend is that the average age of the very well paid is declining. In 1985, it stood around a mature 55 years old. By 1[illegible] the average was down to about 52 years, having posted a steady drop over the past four years. This year's youngest executive is 35-year-old Gary Kennedy, vice president of Oracle Systems Corp. and ranked in 99th place. The oldest was Litton Industries Inc.'s chairman Fred O'Green, 67, ranked at number 20.

These results, coupled with lower average pay increases for the year, imply that 1988 was not such a good year for electronics honchos. Indeed, while sales grew by more than 12% for the top 200 companies, profits were off an average of 3%. At the same time, both return on equity (ROE) and return on investment (ROI) for the same 200 companies fell, and stock prices were slow to rebound after the Crash of October 1987.

A case in point is Seagate Technology Inc., a maker of disk drives. Chairman and CEO Alan Shugart and executive V.P. and chief technical officer Douglas Mahon saw their pay drop steeply in 1988, due to poor company performance, which included a $5.5 million net loss. Both were in the top 10 last year. In the latest survey, Shugart ranked 44th, Mahon 43rd.

Most companies tie bonuses and sometimes salaries to performance. Short-term financial incentives in-



Still sailing right along: the five best-paid execs in the electronics business in 1988 were, clockwise from upper left, Compaq's Rod Canion, Apple's John Sculley, Computer Associates' Charles Wang, Unisys' J. Michael Blumenthal, and IBM's John Akers

clude ROI, ROE and earning per share. Long-term incentives focus on market share growth, productivity improvements and product development speed. In general, the higher the executives, the more their pay is tied to general corporate performance, while compensation in the lower ranks is measured more by individual goals.

IBM's proxy statement gives some insight into what motivates its top executives. "Compensation is directly related to performance and the need to remain competitive with other companies," the report reads. "Approximately two-thirds of this compensation is dependent on business results or the market value of IBM stock." Salaries are determined by "individual contribution and performance," it goes on to say, and annual incentive awards are based on IBM or internal business-unit results.

Luckily for John Akers, IBM's chairman, the company turned in a respectable performance in fiscal 1988. That helped propel him to the fifth slot on the ELECTRONIC BUSINESS list, with an annual salary of more than $1.5 million, nearly double what he made in 1987. It is the first time Akers has been in the ELECTRONIC BUSINESS top 10.

Salaries and annual bonuses are only part of the compensation picture. Indeed, long-term compensation, usually in the form of stock options, has always been a major factor in executive compensation, especially in high technology. Ted Buyniski, a senior compensation consultant at Sibson & Co., believes that an increasing reliance on stock options may in part explain the apparently lackluster performance in electronics compensation.

Chris Blake, senior vice president in San Jose for Lee Hecht Harrison Inc., an executive out-placement firm, however, disagrees. "Equity has always been important to executives in Silicon Valley," she says. ▷

Still, an upward trend in giving stock is present. Over the past 10 years, long-term incentive plans such as stock options have grown from 15% to 42% of total direct compensation, according to Buyniski. On the other hand, base salary has dropped in importance from 60% to 40%, while short-term incentives — namely, bonuses — fell from 25% to 18%.

Long-term incentives grow

One reason is stockholders are demanding that managers be more vested in a company's success. The same goes for outside directors, Buyniski says. How the mix will play itself out in the next few years is unclear, but between one-half and two-thirds of a typical executive compensation package might soon come from long-term stock options, he estimates.

Take Sculley, for instance. He exercised options on the company's 1981 plan over the past three years to the tune of $7 million. He also has options on 767,000 Apple shares at $26.38 under the company's long-term stock option plan. As of December 5, 1988, Sculley beneficially owned 805,762 Apple shares. According to Buyniski, executives like Sculley are more likely to opt for long-term stock plans rather than cash payments, because the potential rewards can be staggering.

In the past, incentive stock options were among the most popular vehicles to motivate executives. But today, with changes in tax laws the trend is toward other stock options, such as nonqualified stock options, stock appreciation rights and performance-based stock plans.

ISOs have waned in popularity because of the removal of the differential between the capital-gains and the income tax rates. Another factor was that the Financial Accounting Standards Board threatened to change the tax treatment of ISOs. Right now, the board has put the issue on hold, and observers don't expect any resurrection of the issue for at least three years.

The one remaining advantage of ISOs is that taxes can be deferred. But even that is a hollow argument. Given the perception that tax rates are lower now than they will be in the foreseeable future, deferment is inconsequential. The same goes for other cash deferment plans.

Measuring performance

The 10 most common performance measures used as executive incentives

Net income	32%
Pretax earnings	30%
Discretionary	19%
Return on equity	18%
Earnings per share growth	16%
Return on assets	14%
Target sales	14%
Return on investment	8%
Target cash flow	5%
Return on sales	3%

Total exceeds 100% due to multiple responses

Source: Sibson & Co.

New and innovative stock option plans are always being devised to replace ISOs. The idea is to increase motivation for the long term, according to Sibson's Buyniski. One such plan relies on future stock prices. Say a company's stock is trading at $20 and is expected to rise to $30 in three years. As a way to entice a high-powered executive, the traditional approach would be to offer options on 1,000 shares at $20 a share.

The new thinking, Buyniski says, is to offer the executive options on maybe 5,000 shares at $30. In this way, the payoff is greater if the executive can grow the company beyond $30 a share. At the same time, the shareholders are more assured the executive will stick around for a while. While a few companies are thinking about this type of approach, none have yet put it into action, he says.

Stockholders are demanding that managers and outside directors be more vested in a company's success

Along the same lines, more companies are employing performance-based stock plans, often with restricted stock. These are shares granted and then later earned by an executive during a given period, usually three to five years, based on the attainment of certain company goals. The value of the award is based on value of the stock at the end of the period or its projected value.

Another critical issue for executives in this age of mergers and acquisitions is the need for a change-of-control contract, also known a golden parachute. "We don't care how big the company is, it makes good business sense," says compensation expert Larry Wangler of Towers, Perrin, Forster & Crosby.

For example, Paul Stern, former president of Unisys Corp., actually earned more than top-ranked John Sculley last year. Stern resigned from Unisys on December 31, 1987, but still raked in more than $2.5 million in 1988. His separation payment came to more than $2 million, plus he made $30,000 a month for the first six months of the year as a company consultant. All told, he took home nearly $49,000 a week in 1988.

There is more. "Among other things," reads the 1988 Unisys proxy statement, "Dr. Stern is entitled to a pension plan (inclusive of social security) in annual amounts ranging from $98,146 at age 55 to $245,364 at age 65 and continued medical plan coverage." All his stock options were also accelerated, including stock appreciation rights. Stern was hired by Northern Telecom Canada Ltd. in March 1989.

Chances are, big separation payments like Stern's will be around in the future, but industry sources say designing them will become more costly and time consuming. The Internal Revenue Service recently formalized its 5-year-old 280G regulations outlining the tax consequences for golden parachutes, making the rules somewhat more rigid.

In essence, an executive is allowed up to 2.99 times his average W-2 pay for the past five years. Any separation payment more than that amount will get hit with an excise tax of 20%. To avoid the added cost, experts are suggesting such alternatives as employment contracts and severance arrangements not contingent on changes in corporate control.

Will 1989 and beyond be better years for executives than 1988? That depends on how well the economy shapes up and how well high-tech stocks perform. Sibson & Co. is forecasting growth this year in total compensation for all industry at around 10%, the same as 1988, and base salary growth of 6.9%, compared with the 6.7% growth in 1988. ☐

Electronic Business

Top paid U.S. executives

Rank	Executive/age	1988 salary	Percentage change from 1987	Company	Position
1	**John Sculley**/49	$2,479,000	15.8%	Apple Computer	Chairman, President, CEO
2	**Joseph R. Canion**/44	1,866,839	35.8%	Compaq Computer	President, CEO, Director
3	**Charles B. Wang**/44	1,794,000	25.4%	Computer Associates	CEO, Chairman
4	**W. Michael Blumenthal**/63	1,662,886	7.3%	Unisys	Chairman, CEO
5	**John F. Akers**/54	1,525,500	81.4%	IBM	Chairman
6	**Anthony W. Wang**/46	1,521,000	28.0%	Computer Associates	President, COO, Director
7	**Lawrence J. Ellison**/44	1,362,500	91.4%	Oracle Systems	President, CEO
8	**John A. Young**/56	1,342,232	12.5%	Hewlett-Packard	President, CEO, Chairman
9	**Melvin Howard**/54	1,269,153	44.9%	Xerox	Vice Chairman
10	**Charles E. Exley Jr.**/59	1,069,390	6.8%	NCR	Chairman
11	**Thomas C. Roberts**/47[1]	1,016,240	149.6%	Control Data	Executive VP
12	**Ben J. Newitt**/63	999,705	138.6%	Applied Magnetics	Vice Chairman, CEO
13	**Orion L. Hoch**/59	997,227	27.4%	Litton Industries	Chairman, CEO
14	**David T. Mitchell**/46	991,941	-26.8%	Seagate Technology	President, COO
15	**John T. Hartley**/58	983,486	20.0%	Harris	Chairman, President
16	**K.V. Cassani**/60	979,750	46.8%	IBM	Vice Chairman
17	**Jack D. Kuehler**/56	969,900	47.8%	IBM	Vice Chairman
18	**Michael H. Spindler**/46	958,000	35.1%	Apple Computer	Senior VP, President, Apple Europe
19	**David R. Tacke**/66	943,898	12.7%	E-Systems	Chairman, CEO
20	**Fred W. O'Green**/67	937,478	-8.3%	Litton Industries	Chairman
21	**Kenneth H. Olsen**/62	931,527	2.9%	Digital Equipment	President, CEO, Director
22	**John C. Lewis**/53	929,588	3.5%	Amdahl	Chairman, CEO
23	**David T. Kearns**/58	928,184	-20.4%	Xerox	Chairman, CEO
24	**Frank G. Hickey**/60	927,750	16.3%	General Instrument	Chairman, CEO
25	**Delbert W. Yocam**/44	923,000	10.9%	Apple Computer	Senior VP, President, Apple Pacific
26	**E. Joseph Zemke**/48	917,129	51.6%	Amdahl	President, COO, Director
27	**Leon Machiz**/64	904,436	11.0%	Avnet	Vice Chairman, COO, President
28	**Bertil D. Nordin**/54	895,874	30.6%	Digital Communications	Chairman, CEO
29	**Joe M. Henson**/55[2]	894,368	21.2%	Prime Computer	President, CEO, Director
30	**Eckhard Pfeiffer**/46	893,188	7.9%	Compaq Computer	Senior VP International Operations
31	**Marshall D. Butler**/62	883,960	30.2%	AVX	Chairman
32	**John V. Roach**/49	871,556	-4.9%	Tandy	Chairman, CEO, President
33	**Ray Stata**/54	869,868	NA	Analog Devices	Chairman, President
34	**Robert M. Price**/58	862,400	-2.6%	Control Data	Chairman, CEO
35	**George B. Harvey**/57	858,538	8.1%	Pitney Bowes	Chairman, President, CEO
36	**Dean O. Morton**/56	840,678	12.1%	Hewlett-Packard	Executive VP, COO, Director
37	**William J. Weisz**/61	824,256	10.5%	Motorola	Vice Chairman
38	**William W. Lane**/54	812,352	-1.8%	Emerson Radio	Chairman
39	**Stephen L. Lane**/52	812,352	-1.8%	Emerson Radio	President
40	**Jean-Louis Gassee**/44	800,000	-3.7%	Apple Computer	Senior VP, President, Apple Products
41	**Jerry R. Junkins**/51	798,250	16.5%	Texas Instruments	Chairman, President, CEO
42	**William R. Anderson**/49	796,521	NA	Applied Magnetics	President
43	**Douglas K. Mahon**/47	788,061	-38.1%	Seagate Technology	Executive VP, Chief Technical Officer
44	**Alan F. Shugart**/57	762,048	-39.7%	Seagate Technology	Chairman, CEO
45	**James A. Unruh**/47	756,771	-4.9%	Unisys	Executive VP
46	**John F. Mitchell**/60	751,659	10.6%	Motorola	Vice Chairman
47	**Horace G. McDonnell Jr.**/60	749,948	90.0%	Perkin Elmer	Chairman, CEO
48	**W.J. Sanders III**/52	738,863	-30.1%	Advanced Micro Devices	Chairman, CEO
49	**Andrew S. Grove**/52	736,487	5.7%	Intel	President, CEO, Director
50	**James L. Donald**/57	732,224	7.9%	DSC Communications	President, CEO

[1] resigned December 12, 1988

[2] resigned December 30, 1988. Mr. Henson also received the additional sum of $1,152,500 upon his resignation

(Continued)

Electronic Business

Top paid U.S. executives

Rank	**Executive**/age	1988 salary	Percentage change from 1987	Company	Position
51	**Edward M. Esber, Jr.**/36	$731,934	-16.3%	Ashton-Tate	Chairman, CEO
52	**Ward D. Parkinson**/43	718,918	NA	Micron Technology	Vice Chairman
53	**Albert A. Eisenstat**/58	718,000	12.2%	Apple Computer	Senior VP, Secretary
54	**John F. Gribi**/47	715,868	10.1%	Compaq Computer	Senior VP Corporate Administration
55	**Robert W. Galvin**/66	700,000	16.7%	Motorola	Chairman
56	**Edward Botwinick**/54	698,602	NA	Unisys	Senior VP
57	**Gordon E. Moore**/60	697,987	2.0%	Intel	Chairman
58	**Michael S. Swavely**/35	695,622	15.9%	Compaq Computer	VP, Sales & Marketing
59	**Joseph L. Parkinson**/43	691,294	NA	Micron Technology	Chairman, CEO
60	**F.A. Metz, Jr.**/55	689,513	52.6%	IBM	Senior VP
61	**Thomas A. Vanderslice**/57	680,183	4.6%	Apollo	Chairman, CEO
62	**Ryal R. Poppa**/55	678,766	-21.0%	Storage Technology	Chairman, CEO, President
63	**William E. Johnson**/46	671,515	30.5%	Scientific-Atlanta	Vice Chairman, CEO, Director
64	**George E. Safiol**/56	665,000	37.0%	General Instrument	President, COO
65	**George M.C. Fisher**/48	659,877	35.2%	Motorola	CEO, President & Director
66	**Joseph T. Casey**/57	655,332	22.5%	Litton Industries	Vice Chairman, CFO
67	**Sidney Topol**/63	654,837	-4.5%	Scientific-Atlanta	Chairman
68	**James M. Harris**/45	645,900	NA	Compaq Computer	VP Engineering
69	**Jack C. Davis**/50	645,890	33.6%	Dataproducts	Chairman, President, CEO
70	**William F. Glavin**/57	645,675	-19.3%	Xerox	Vice Chairman
71	**Eugene R. White**/57	640,994	-6.1%	Amdal	Vice Chairman
72	**Dennis C. Fill**/59	629,141	57.1%	Westmark International	Chairman, CEO, President
73	**Paul A. Allaire**/50	627,312	-11.5%	Xerox	President
74	**G.P. Sprague, Jr.**/52	626,322	NA	Applied Magnetics	Executive VP
75	**Jerry K. Pearlman**/49	621,750	42.9%	Zenith Electronics	Chairman, President, CEO
76	**Bernard S. Appel**/57	620,948	-5.9%	Tandy	President Radio Shack Div
77	**Robert J. Potter**/55	618,000	NA	Datapoint	President, CEO
78	**E. Gene Keiffer**/59	615,099	21.2%	E-Systems	President
79	**Walter F. Raab**/64	611,990	13.1%	AMP	Chairman, CEO, Director
80	**Gary L. Tooker**/49	605,919	25.4%	Motorola	COO, Sr. Exec. VP, Director
81	**Ronald W. Braniff**/52	588,813	NA	Ask Computer Systems	President, CEO
82	**Curtis A. Hessler**/45	588,125	NA	Unisys	Executive VP
83	**David A. Bossen**/62	581,009	7.0%	Measurex	President, CEO, Director
84	**William E. Terry**/55	579,494	8.7%	Hewlett-Packard	Executive VP, Director
85	**James C. Morgan**/50	579,207	NA	Applied Materials	Chairman, CEO
86	**M. Howard Dingman, Jr.**/62	578,527	15.9%	Litton Industries	Senior VP
87	**Hollis L. Caswell**/58	575,981	9.3%	Unisys	Senior VP
88	**Edson D. de Castro**/50	575,942	36.7%	Data General	President
89	**James J. Renier**/59	574,516	-33.3%	Honeywell	Chairman, CEO, Director
90	**Charles E. Sporck**/60	571,615	48.9%	National Semiconductor	President, CEO
91	**Edward F. Kosnick**/44	570,000	34.1%	Sprague Technologies	President, CEO
92	**Roger W. Johnson**/54	565,578	4.3%	Western Digital	Chairman, President, CEO
93	**Thomas D. Sege**/62	562,485	27.0%	Varian Associates	Chairman, CEO
94	**O. M. Fundingsland**/46	560,633	NA	Applied Magnetics	Executive VP Sales and Marketing
95	**Edson W. Spencer**/62	557,620	-45.0%	Honeywell	Chairman, Director
96	**W. Frank King III**/49	556,271	NA	Lotus Developement	Senior VP
97	**Jim P. Manzi**/37	550,004	-41.5%	Lotus Developement	President, Chairman, Director
98	**Gaynor N. Kelley**/57	548,063	NA	Perkin Elmer	President, COO
99	**Gary Kennedy**/35	546,760	31.1%	Oracle Systems	Senior VP
100	**Leslie L. Vadasz**/52	545,500	4.9%	Intel	Senior VP, Director

Source: ELECTRONIC BUSINESS

European auto market beckons chip producers

New emissions rules for European Community nations plus automakers' awareness of their own lag in using electronic components add up to big opportunities

BY ANDY ROSENBAUM

The global automobile market has become increasingly important to semiconductor producers. But if chip makers have been depressed by a U.S. car market that is stuck in neutral, they should look eastward to Europe, where car sales are zooming along in overdrive.

The boom in European car sales continues, running above what is expected for this year. According to DRI Europe, a research and consulting concern in London, 11.75 million units were sold in European Community (EC) countries in 1988; this figure is predicted to rise to more than 12 million units this year.

The European car market should continue to demand significantly more chips than the U.S. market in the next few years, observers say. An EC decision on auto emissions doesn't hurt, either. The ruling will step up demand for electronic mixture controls, representing a bonanza for integrated-circuit (IC) producers. So far, European car makers have lagged way behind those in the United States and Japan in exploiting electronics technology.

"The average spent on electronics per car in the EC is currently only about $50," says Dennis Exton, an analyst with UBS-Phillips & Drew in London. "By 1992, we expect it to reach $250." According to market research firm Dataquest Inc. in San Jose, the average per American vehicle was $95 last year, forecast to rise to $133 in 1992.

The EC decision on auto emissions will provoke the first spurt of growth. In June, after weeks of stormy disputes, the EC reached a definitive agreement on automobile emissions. The tough new standards to be introduced in 1990 make use of electronic mixture controls obligatory on a wide range of cars. Manufacturers all over Europe are adapting to the change. The electronics division of Ford Motor Co. in Michigan is building a new plant in Spain to provide the necessary components; in Torino, Italy, Fiat SpA has already offered several new car lines with the controls as part of the standard model.

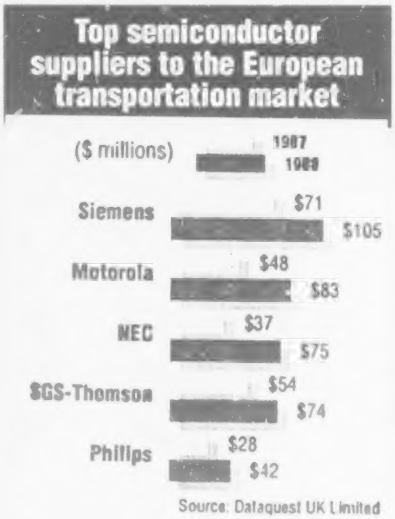
Change in attitude

Just as important as the change in EC regulations will be the change in attitude toward electronics on the part of European car manufacturers.

"The Europeans were skeptical about using electronics to provide better product differentiation," says Karl Ludvigsen, managing director of the automotive consulting firm Ludvigsen Associates Ltd. in London. A problem car manufacturers face everywhere is convincing the consumer that a particular product is special, he adds.

BMW was one of the first European automobile manufacturers to recognize the advantages of electronics for marketing. At a convention in Scotland last year, BMW's electronics manager Peter K. Thoma called for closer cooperation between semiconductor producers and European car manufacturers.

Top semiconductor suppliers to the European transportation market



Source: Dataquest UK Limited

"In fact, this close cooperation is essential," insists Enrico Ferrati, research and development manager at Magneti Marelli SpA in Italy. The Fiat-owned auto component producer — one of Europe's largest — spent $40 million on semiconductors in 1988 and expects that to increase by 20% this year.

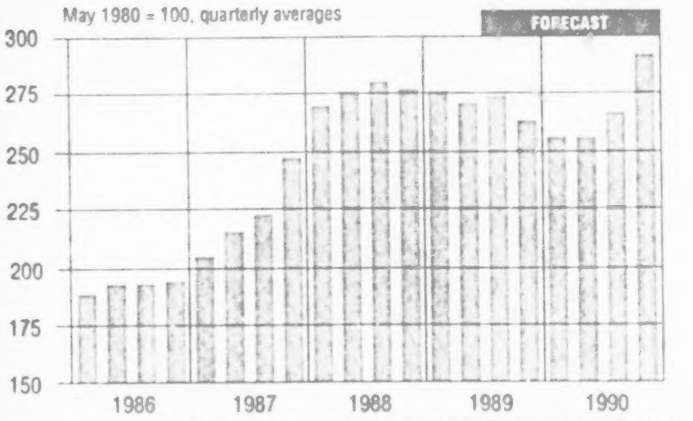
"The trend is for an automobile manufacturer to buy an entire system from a components producer, not just isolated parts," Ferrati says, pointing out that his company maintains a center for product development and works directly with IC producers to design components.

Competition in the automobile market will be ferocious, analysts contend. Many of the major European IC producers have already targeted automobiles as a growth area.

Intel Europe is already selling several million units a year to the transportation sector, automotive marketing manager Jamie Kirk says. "Networking controllers are going to become a big part of the market in Europe," he adds. "The object will be to create a single system that reads the road, observes vehicle speed, etc. All the different modules will communicate with each other, enabling greater flexibility. This is definitely a growth area."

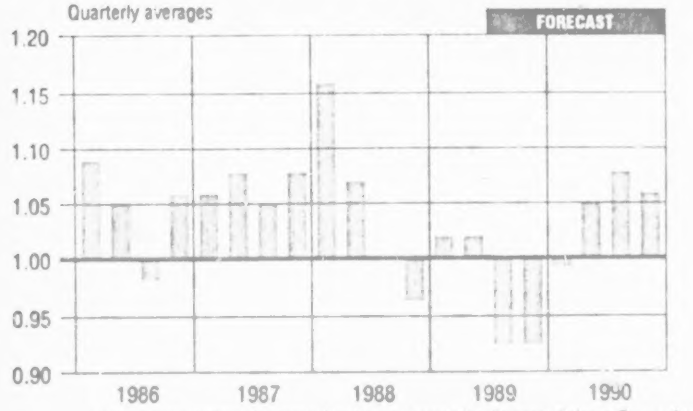
Hitachi Europe, based in London, is also working closely with automobile producers to exploit the fast-growing market. In May, it introduced two new integrated circuits intended specifically for automotive components. ☐

Distributors' shipment index



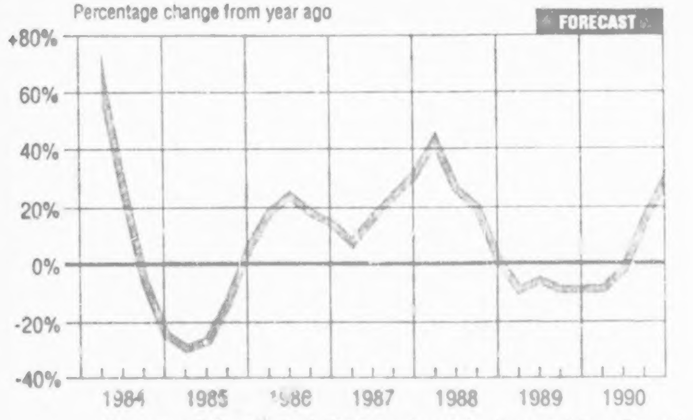
Data source: National Electronic Distributors Association; Forecast: Cahners Economics

Distributors' book-to-bill ratio



Data source: National Electronic Distributors Association; Forecast: Cahners Economics

Distributors' new orders



Data source: National Electronic Distributors Association; Forecast: Cahners Economics

Distributor orders drop again — what's next?

Rumbles of a slowdown have been building for months now in the electronics industry. For distributors, the rumblings have suddenly blasted loud and clear through the bullhorn we call bookings. Bookings, or new orders, provide some hint of what's to come for shipments ahead — and the news is just as expected. Bookings had dropped 10% in the first quarter of 1989 from the first quarter of 1988. Now, the National Electronic Distributors Association (NEDA) reports second quarter bookings also fell 6% from the year-ago quarter.

That's the first time bookings have slipped relative to year-ago levels for two consecutive quarters since the end of 1984. But as I've been writing over the past year, this current economic slowdown will be far different than the 1984-1985 distributor debacle. For example, bookings dropped 6% in the third quarter of 1984 from year-ago levels and then tumbled 25% in the final quarter of 1984. The last recession hit hard and fast.

Forecast for distributor orders

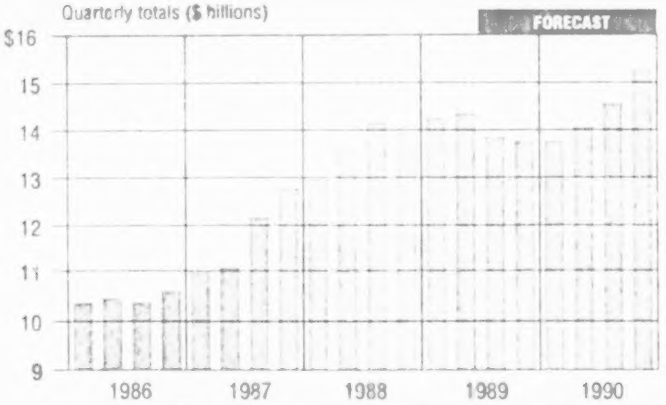
I continue to believe that the current distributor downturn will be softer and slower than in 1985. Cahners Economics' forecast for distributor orders projects another 10% decline in the latest summer quarter and a 9% drop in the final quarter of this year. But after two more quarterly declines in early 1990, distributor bookings are expected to begin rising again by next summer.

What anchors this optimism? First, distributors are in better shape this time around. Average revenue per employee jumped 17% from 1987 to 1988 as time-saving, employee-saving new technologies have been implemented. Inventories are being watched more closely now than ever before. And distributors, burned badly in 1985, are refusing to be burned again by responding early to signals of a slowdown now.

Of course, this is an economic projection — and lots of assumptions on which a forecast is built can change. Every forecaster says that; it's sort of our version of caveat emptor. Will my forecast for distributor orders be correct? Only time will tell. So check back in this column next quarter.

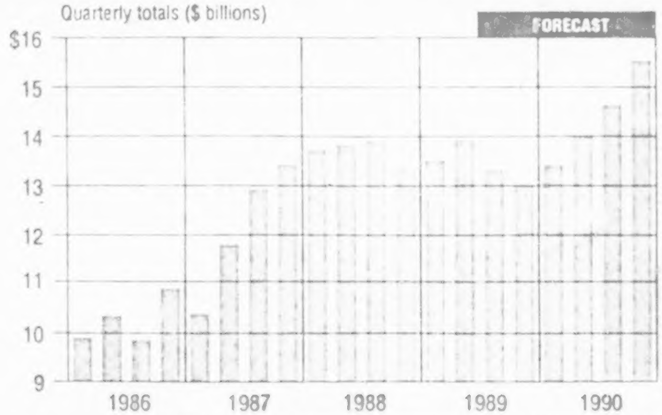
ELIZABETH B. BAATZ

Electronic component shipments



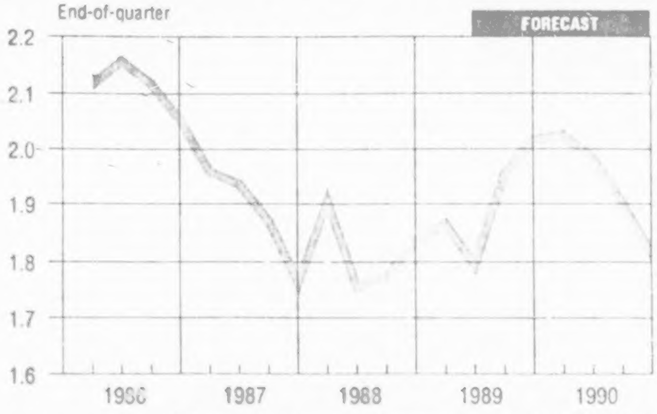
Data source: U.S. Commerce Department; Forecast: Cahners Economics

Electronic component new orders



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Electronic component inventory-to-shipments ratio



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Component shipments still growing . . . slowly

Like the computer, instrument, distributor and other electronic markets, components manufacturers have also succumbed to an economic slowdown. U.S. manufacturers shipped $14.5 billion worth of resistors, capacitors, printed circuit boards, semiconductors and other types of electronic components in the past spring quarter, according to the U.S. Commerce Department's survey of component factory shipments. Not bad. That $14.5 billion stood 1.4% higher than the previous quarter's shipments and 6.4% higher than a year earlier.

Still, for the 12 months ending June 1989, component shipments grew at a 10.2% pace, down from a peak 19.6% pace set during June 1988. The slowdown has been even more noticeable on the bookings front. Bookings, or orders, surged ahead at a 26% rate in the 12 months ending May 1988. For the 12 months ending June 1989, bookings rose at a mere 1.4% rate.

Worse yet, the slowing pattern of bookings and shipments has been going on for more than a year now. So whether we like it or not, the economic business cycle has exerted its inexorable downward pull on the components industry. The Commerce Department data do not represent an unusual blip in long-run growth. The data suggests a trend has indeed been in the making.

Slowing orders for U.S. components reflects weakness in the computer industry. The computer industry's book-to-bill ratio has fallen below one in 18 of the past 29 months. Bookings for computers and office equipment have also been slowing for the past year. Exports, which had been boosting computer sales, have slumped. Business investment in computers, while still necessary, will hit a temporary barrier in 1989 and early 1990 as lower profits translates into fewer equipment purchases.

The only question remaining for component makers: How long and how deep will this current downturn last? The answer for any one company will vary depending on product mix, share of international sales, and other such factors. Cahners Economics predicts component shipments for all U.S. factories will grow 3% this year and 2% next year, with a minor two-quarter decline in the latter half of 1989. Even if computer makers fare worse than the small slowdown we now assume, component makers could still skirt a deeper recession — thanks to the still low level of inventories that component makers are carrying now.

ELIZABETH B. BAATZ

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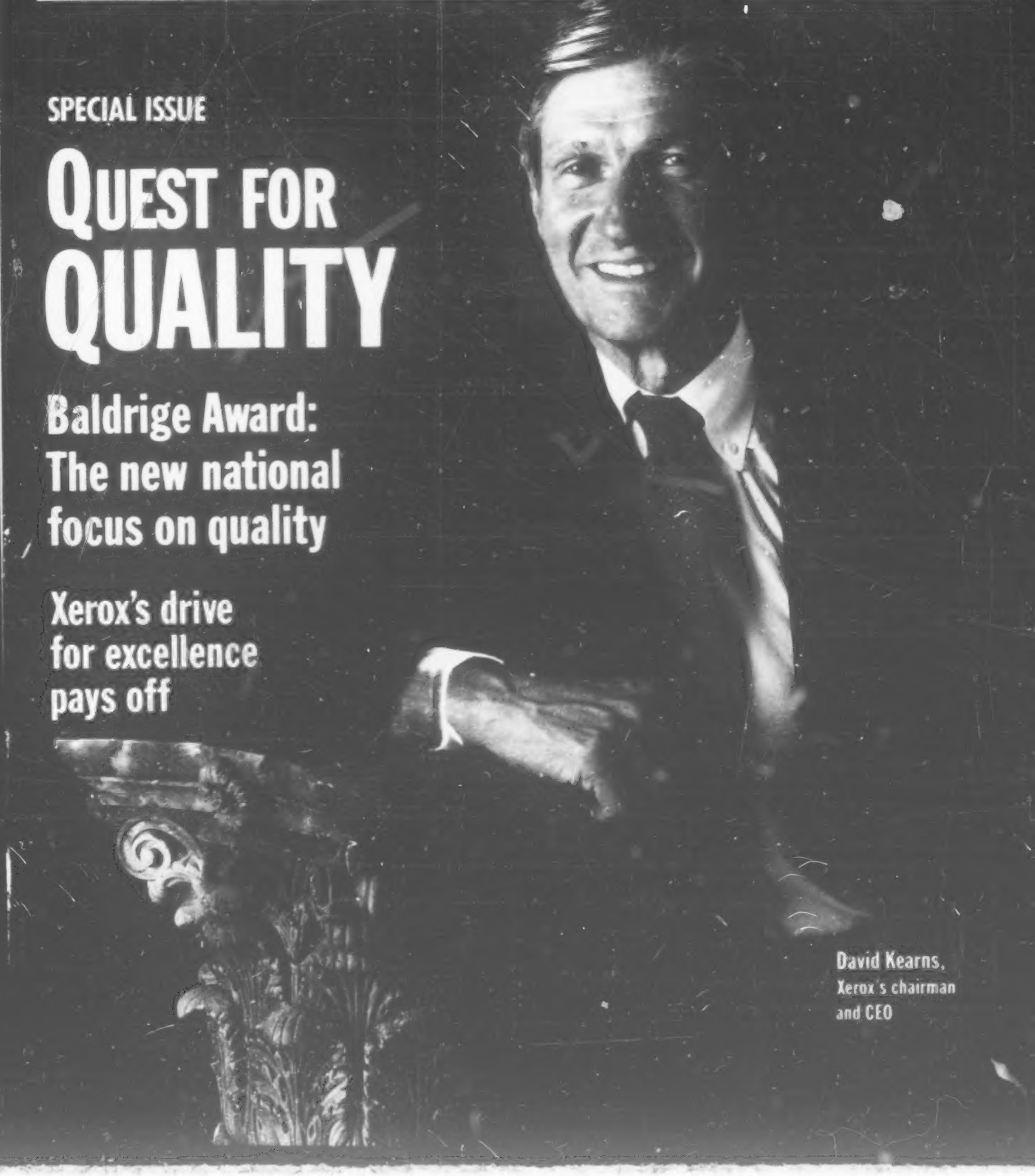
Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIE [illegible] RLDWIDE

OCTOBER 16, 1989



SPECIAL ISSUE

QUEST FOR QUALITY

Baldrige Award: The new national focus on quality

Xerox's drive for excellence pays off

David Kearns,
Xerox's chairman
and CEO

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES — WORLDWIDE

VOL. 15, NO. 20 OCTOBER 16, 1989

PAGE 50 Xerox chairman and CEO David Kearns: His visits to Japan to review quality principles culminated in the Xerox Leadership Through Quality program

COVER STORY

50 Back from the brink: Xerox redefines its notion of quality

"They simply were eating our lunch" is the way one Xerox official puts it. The era was the late 1970s, when the company whose name is synonymous with photocopying was steadily losing market share to its Japanese rivals. Such a painful revelation was gained through countless trips to Japan by Xerox chairman David Kearns and other executives — forcing the giant electronics company to step back and examine old habits, then set demanding new goals for quality.

17 Robert A. Mosbacher, U.S. Secretary of Commerce

The Malcolm Baldrige Quality Award "offers a unique mechanism for cooperation between business leaders and quality experts throughout the private sector and government."

19 Robert W. Galvin, Motorola chairman

"Leading the acceptance of the newest and best practices and processes for achieving quality is a responsibility of each individual manager."

24 New thinking on quality

Indeed, there is a quality revolution occurring today in the United States. No longer is quality simply seen as an added cost of making acceptable products, but extends to improving relationships with customers, suppliers and employees as well. This new thinking promises to transform the cultures of organizations, and, ultimately, could change American society.

Cover photograph: Jonathan Levine

34 Baldrige Quality Award: Industry's version of Oscar

How tough is winning the Malcolm Baldrige National Quality Award? Very tough, according to both winners and losers. Wrapping up only its second year, the program goes far beyond the public relations value of a national quality award.

44 Baldrige application process a long, rigorous examination

Although the 1990 Baldrige Award will not be presented for 13 months, it is not too early for companies to plan their entries. But the journey is taxing — from a comprehensive self-appraisal to site visits by Baldrige examiners.

60 Motorola's unique problem: What to do for an encore

As an inaugural Baldrige winner, Motorola may not compete again for five years. With its eyes no longer on the prize, can this champion stay in top form? Affirmative, says president and CEO George Fisher. Motorola is now shooting for the seemingly impossible goal of "Six Sigma quality" by 1992.

72 Solectron's Chen crusades for U.S. manufacturing excellence

The president of this San Jose contract manfacturing firm offers a solution — and a challenge: Blend the best of Japan and the United States and raise the status of manufacturing to the heights enjoyed by marketing.

80 Baldrige winners start ahead of the pack

While the Baldrige Award is far from a household name, it nonetheless has achieved a global following among electronics industry leaders. Win one and your company becomes a "quality guru," like Japan's best. Sure to follow are fame, fortune and a marketing bonanza.

88 Preachings of quality gurus: Do it right the first time

W. Edwards Deming, Philip B. Crosby, Joseph M. Juran and Armand V. Feigenbaum are widely viewed as four leading American pioneers of quality. They say U.S. industry is getting better in its quest for quality, but there's still a long way to go.

Continues next page

PAGE 80 **Winners of the Baldrige award start ahead of the pack**

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Robert Mosbacher, Secretary of Commerce: Baldrige Award joins government and industry

PAGE 19
Robert Galvin, Motorola chairman: Leads winner of inaugural Baldrige Award

PAGE 235 **Bourns Networks' Bing Harding: Statistical process control is not quality assurance, it's a business philosophy**

101 **Hewlett-Packard unravels the mysteries of quality**

Spurred by the quick turnaround of a Japanese joint venture, the electronics giant is inspired to turn its attention to details — first hardware, now software.

111 **These days, Intel thinks impatience is a virtue**

The microprocessor maker is intent on designing its chips right the first time. The new motto is (PDQ)^2 — "Perfect Design Quality, Pretty Darn Quick."

121 **Spreading the gospel: Quality is everybody's business at TI**

Texas Instruments is not a flashy company. But one thing that rouses its normally phlegmatic executives is the issue of quality. Carrying the banner are 4,300 corporate-wide teams.

131 **Financial analysts figure the bottom line on quality**

Several experts who follow electronics say that, while quality has improved throughout the industry, measuring the effectiveness of programs is debatable.

136 **Credo at small companies: Quality equals simplicity**

For executives at smaller electronics firms, the quantitative side of quality programs — paperwork — is too much of a burden. The idea is to keep quality programs simple. The slogan "quality is everyone's job" rings especially true at small companies.

149 **The Pentagon revives its interest in quality**

Compared with industry, the U.S. military lags far behind in the quest for quality. But with a new quality czar behind the wheel, Defense now promises a big push. Over the next few years, the goal is to chip away at layers of bureaucracy in an attempt to effect a cultural change.

161 **Rockwell commits to organizational excellence**

In December 1987, Rockwell International published a one-page document that declared to the world what the aerospace and electronics giant stands for. Rockwell's credo is the cornerstone for a new quality culture that is rooted in "organizational excellence."

191 **At Compaq, reaching the top begins at the bottom**

Trying to top IBM on quality is no mean feat. Whether in manufacturing or human resources, at Compaq the process starts with the worker.

199 **Avnet, other distributors getting into the groove**

Distributors regularly trail the rest of the electronics industry in major trends, and quality is no exception. But they are learning that poor quality costs dearly.

209 **Design automation vendors define quality on own terms**

In software, standard definitions of quality simply do not apply. Suppliers of design tools must develop their own procedures to track performance.

222 **Education: At the heart of quality**

For years, U.S. industry has done a good job of training workers. But now, in an increasingly competitive global marketplace, training alone just won't cut it. Electronics industry executives are realizing that while training teaches skills, it is education that lays foundations and creates a winning culture.

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At the resistor networks unit of this components firm, an obsession with statistical process control data has yielded new business and double-digit growth.

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Having survived a painful production transition, the rigid disk drive maker is learning from its Japanese manufacturing partner that the bottom line to high yields is quality.

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The world's leading connector maker employs a strong work ethic and a streamlined organization to boost quality management and cut costs.

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The U.S. chip maker's quality program has been so successful over the years that now its Dutch parent N.V. Philips is transplanting it to Europe.

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Bracing for tougher global competition in a unified marketplace in 1992, Europe's corporate giants have begun spreading the quality crusade to top management.

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Meeting specs? Is that all there is to quality?

Whatever happened to zero defects? An informal ELECTRONIC BUSINESS *survey reveals that the concept is hardly uppermost in the minds of some U.S. electronics executives*

BY JOHN KERR

It is not encouraging. Many U.S. electronics firms still view quality as a process of meeting specifications, not of exceeding them; neither are they striving for zero defects nor anticipating customers' future needs.

That's the key conclusion from an informal telephone poll of top electronics industry executives conducted recently by ELECTRONIC BUSINESS. The poll, conducted in mid-July, drew 65 detailed responses from chief executives, presidents, executive vice presidents and other senior staffers of major industry players.

While there is much to prove that electronics managers have the customer firmly in mind, their responses reveal a fixation with "conformance" and "compliance" with customer specifications. The terms are depressingly passive. The managers' emphasis seems to be on toeing the line; their goals — such as levels of products returned — would make a proselytizer of quality such as W. Edwards Deming weep.

Here is how one top manager defines quality: "It is the production of adequate products and services that are reliable, maintainable and reusable." Tries another: "Our goal is to have equipment operational on delivery 99% of the time."

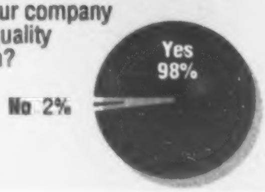
In today's dog-eat-dog market, "adequate" translates into "also-ran." And 99%, if applied to landings at Chicago's O'Hare Airport, would still mean 20 unsafe landings a day.

The executives' answers show scant recognition that quality is a moving goal or that defects can be driven out. It is easy to distinguish, by the replies, those who live by quality and those who have to scramble to patch together a definition. The poll wasn't a test, but full marks nevertheless to those who described quality as the vehicle for meeting and then exceeding customers' specifications via every one of their corporate departments.

The poll turned up other interesting findings: as a kind of Oscar of quality, the Malcolm Baldrige National Quality Award hasn't, in its two short years, attained star status itself. It clearly involves a substantial corporate commitment of time and money: a tiny percentage of the electronics industry plans to enter for the award this year, although there is much more participation planned from 1990 onward. And it is long overdue; many in the U.S. electronics sector believe that the Baldrige Award, with its unique incentive mechanisms, provides a powerful stimulus to better the quality of U.S. goods and services overall.

Everyone loves quality. And then?

Does your company have a quality program?



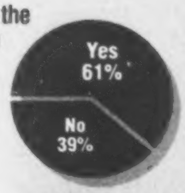
This is rather like asking: "Do you have lungs?" An apple-pie issue, quality at least acquires nominal program status in virtually every U.S. electronics firm. What's unclear is how much is lip service.

Some respondents described their programs in terms of the quality handbooks they live by, the final test operations they run, the vice presidents for quality they had appointed, the quality assurance auditors they send out, the statistical process control manufacturing procedures they've implemented. Others broadened the scope to put sales and service under the quality-program umbrella as well.

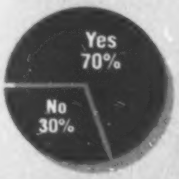
Defense contractors tended to define their programs by the mil-spec boundaries they must meet. Some others put it in terms of customer-imposed quality standards. One nice response: "Our quality-control program runs through the whole company. Workers are encouraged to think of the next guy on the line as the customer."

Baldrige Award? Great idea, say those who've heard of it

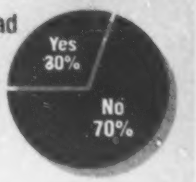
Are you aware of the Malcolm Baldrige National Quality Award?



Are you aware of the Deming Prize in Japan?



Have you seen/read the application guidelines for the Baldrige Award?



Perhaps the U.S. Commerce Department should have put more taxpayer money into publicity, because the Japanese prize that bears quality dean Deming's name is much better known than the Baldrige Award, now being sponsored for the second year by the U.S. government. Far fewer people have actually seen the Baldrige guidelines: under 30% of respondents.

Conclusion: yes, word of the Baldrige competition is rippling out rapidly, but the Commerce Department could perhaps put more weight behind its publicity — at risk of making its judging job tougher. Why? Because the very act of studying the guidelines, let alone going through the rigamarole of application, is itself a quality consciousness-raiser.

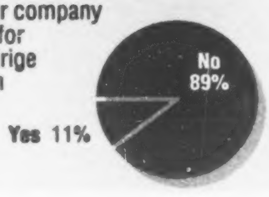
At least one Baldrige Award mechanism has kicked in already: the requirement that winners — aspirants, too — get their suppliers to go for it. Three respondents mentioned exhortations from Motorola Inc. and IBM.

Respondents were overwhelmingly positive about the Baldrige Award. "Long overdue," "Excellent idea" and "It is a very noble goal" were typical comments. There was even more enthusiasm for the Deming Prize: "It has pushed the Japanese to produce efficient products at very low cost," said one executive. Remarked another: "It's a very good idea. We could have had it here if we'd listened to Mr. Deming 30 years ago."

Most executives observed that the Baldrige Award guidelines are long, but well-developed and thought through.

Who's applying for the Baldrige Award?

Has your company applied for the Baldrige award in 1989?



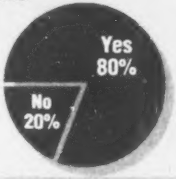
At first glance, the low proportion of 1989 applicants for the Baldrige Award is disappointing. But it is likely that this reflects the rigor of the application procedure more than the award's perceived worth.

There is also the time factor: It takes months of preparation before a company can call itself ready.

Executives offer recommendations on quality

What about a U.S. national program to improve quality?

Should the United States have a national program to improve quality?



Respondents voted overwhelmingly for some kind of national quality program, but their recommendations were as varied as the companies they work for. One consistent theme is that government should not directly run such a program, but that industry should take the initiative itself. And many of those polled believe that a version of the Deming Prize should be offered as an incentive in the United States, as it is in Japan. Here's a sampling of the suggestions made by senior electronics industry executives:

"The real solution is lower interest rates. Make capital more available to improve equipment to turn out better products."

Marshall Butler, chairman and CEO,
AVX Corp.

"Large purchasers should require their vendors to take on quality programs."

Steven Goldby, president and CEO,
Molecular Design Ltd.

"It should be a cooperative program among related companies."

Sidney Jerson, chairman,
Astrocom Corp.

"The government should recruit a leader like Lee Iacocca. We need a popular, motivating figure to get the program rolling."

Malcolm Green, CEO,
Informer Computer Terminals

"It should strive to make products that have zero defects. Statistical process control is an excellent tool that the government should promote."

Frank Fuggini, vice president
for operations, Kollmorgen Corp.
PCK Technology division

"There should be some meaningful education offered to companies on how to improve quality, not just waving of the flag."

Richard Tanaka, president,
Lundy Electronics and Systems Inc.

"Make it industry-sponsored; government involvement would just screw it up."

T. Kevin Duningan, president,
Thomas & Betts Corp.

"Private consulting companies should get more involved and help set guidelines for manufacturing companies on quality."

Herbert Amster, CEO,
Irwin Magnetic Systems Inc.

"It should move companies away from Wall Street quarterlies."

R.F.Carlin Jr. COO,
Vitro Corp.

"Private business should create the 'Quality Commission' — like the baseball commissioner — to inspire and support the program."

Alan Devine, vice president for
operations, Corporate Software Inc.

"The government should not fund improvements, but they should provide conferences that will outline the objectives of the improvement program."

Dave Beard, director of quality
assurance, Scope Inc.

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SIX DOLLARS

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES—WORLDWIDE

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Rod Canion,
Compaq's president
and CEO

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

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PAGE 24 Compaq's Rod Canion and recently introduced laptop: Balancing innovation and a no-nonsense conservative business strategy

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24 Compaq stays the course

Methodical, thorough, conservative, boring. Those adjectives have been used at one time or another to describe the Houston-based computer company. While such a style may contrast directly with other high-flying vendors such as Apple and Sun Microsystems, Compaq's conservative business philosophy has served it well. A secret to Compaq's success, offers top executive Rod Canion: "We concentrate on laying the foundations correctly."

BUSINESS TRENDS

14 "Dollars for DRAMs": TI gets its cash up front

Texas Instruments' Semiconductor Group, always trying to outsmart the mighty competition in the memory market, has been asking some customers for "advance payments" in an effort to fund and manufacture increasingly expensive future DRAM products.

19 White House pushes for advances in supercomputing

In an attempt to bolster the U.S. edge in supercomputers, the Bush administration plans to spend nearly $2 billion over five years to improve communication links between existing and future models of the high-speed machines. But more juggling will be needed if the network is to spread beyond academia.

STRATEGIES

24 Compaq stays the course

How has Compaq succeeded so well in a market dominated by IBM and crowded by an uncountable number of personal computer "clone" makers? Some principal reasons: Compaq focuses on the high performance end of the market, has the ability to develop products quickly using leading edge technology, establishes name brand recognition, and sells exclusively through authorized dealers and resellers.

34 Personal computer have-nots fight for bigger slice of market

There's good and bad news in the personal computer industry. On the down side, market growth has slowed, and, for smaller vendors, the business arena is increasingly being dominated by the triumvirate of IBM, Compaq and Apple. But the silver lining is that the PC market is one in which "slow growth" this year still means sales increases of 15% to 20%, surpassing most segments of the computer industry.

BEST IN ELECTRONICS

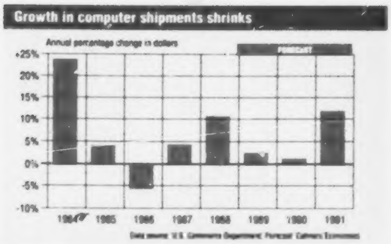
38 The John Young way keeps the legacy of HP intact

With 31 years woven into the fabric of Hewlett-Packard Co., president and CEO Young is the management distillation of the fabled "HP way" set down by legendary founders William Hewlett and David Packard some 50 years ago. According to those who have observed him, Young epitomizes the *right* way to run a U.S. manufacturing firm. So, perhaps, it is no surprise that Young and HP are the winners in this year's annual ELECTRONIC BUSINESS Best Executives and Best Companies survey.

42 The Best Executives and the Best Companies

This year's survey is based on the opinions of ELECTRONIC BUSINESS subscribers from the management and financial communities. Not surprisingly, differences exist between the two samples because of their varying perspectives on the electronics/computer industry.

Cover photograph: Jonathan Levine



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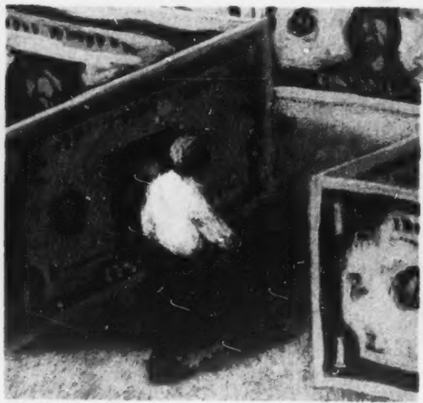

PAGE 50 High tech steps into an uncertain tax future

PAGE 66 Avnet's Leon Machiz: "We're talking about even more centralization"

MANAGING RESOURCES

50 High tech steps into an uncertain tax future

One year after the full force of the 1986 tax reform hit corporate America, the electronics industry appears to have survived the worst of the bloodletting. According to the exclusive ELECTRONIC BUSINESS tax survey, the top electronics industry taxpayers saw their total bills rise only 7% last year. The big question, though, is, what's in store tax-wise in 1990? The answer: uncertainty.

53 **Top industry taxpayers**

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56 Power supplies: Is bigger better?

While smaller U.S. power supply makers grasp at strategies for survival under adverse conditions, recently spawned British multinationals — Astec and Unitech — are targeting customers who themselves are increasingly manufacturing and marketing multinationally. The U.S. companies, to keep pace, may have to copy such tactics.

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61 Fall from the throne: China turmoil topples entrepreneur

A short year ago, Wan Runnan's Beijing Stone Computer Group was China's top private computer company. Today Wan is a political exile in Paris assessing where it all went wrong.

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66 National distributors tighten their belts

Coming off a three-year period of brisk sales, distributors are repositioning themselves to weather some tough times. As component makers push for bigger sales volumes and customers demand more value-added services, distributors are shifting their focus to taking a much harder look at profitability.

70 Avnet takes aggressive stance to build profits

Where there is Leon Machiz, there is fire. The new chairman and chief executive of Avnet is turning up the heat on the largest electronics distributor in order to cut expenses and bring more to the bottom line.

BUSINESS BAROMETER

78 **Consumer electronics**

While other electronics industries are experiencing weaker sales growth this year, consumer electronics holds its own.

79 **Computers**

With backlogs at historic lows, the computer industry may be getting into a real bind should the economic contraction go deeper than currently expected.

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Let's raise our expectations

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While other vendors try to remake the computer industry in their own image, Compaq has concentrated on building sales and profits — its own way

Compaq stays the course

BY RICK WHITING

Methodical, thorough, conservative . . . yes, even boring. Michael S. Swavely acknowledges that at one time or another, Compaq Computer Corp. has been described as all of those and more.

"And we're not ashamed of that," says the personal computer company's president of North American operations. "We've just done a very consistent job of managing our business."

Compaq's business style directly contrasts with other high-flying, counterculture computer vendors such as Apple Computer Inc. and Sun Microsystems Inc., whose charismatic leaders seek to turn the computer industry on its ear. At Compaq, "management's goal is to benefit from change, rather than to cause it," concludes a recent Wall Street analyst's report on the company entitled "Compaq Computer: Profits, Not Prophets."

High-profile Sun president and chief executive Scott McNealy was once quoted as saying that Sun's business decisions were often based on intuition and emotion and, in the case of one product, "90% assumption and 10% fact."

Compare that with an answer Compaq president and chief executive Joseph R. "Rod" Canion gave when asked about Compaq's strategy for entering the Japanese market: "We will go into Japan as we have gone into other areas, which is, very well prepared. Having done our homework on the market, having tailored our strategy for the market. What's delayed our entry into Japan is that it is not like any other market we've ever been in. So a lot more dedication of resources is necessary to do it right."

Currently, Compaq has little presence in Japan, and Canion says that it will be one to two years before the company begins a serious effort to crack that market.

While that studied approach may not generate the cult-like aura that surrounds more impulsive companies such as Sun and Apple, Compaq's conservative business philosophy has served it well. The company holds an estimated 6.9% share of the world (dollar volume) personal computer market; for comparison, IBM holds 15.3%. Compaq has become IBM's major competitor in the microcomputer arena, and this year Compaq is expected to report sales of around $3 billion, up from just over $2 billion in 1988.

Secrets of success

How has Compaq succeeded so well in a market dominated by IBM and crowded by an uncountable number of personal computer "clone" manufacturers? Compaq executives and industry watchers cite a number of reasons: the company's focus on the high performance end of the market; its ability quickly to develop products using leading edge technology; the ability to establish name brand recognition; and the decision to sell exclusively through authorized dealers and resellers.

But Compaq's strengths will be tested in the near future. The vendor could face competition from a more aggressive IBM as both race to incorporate Intel Corp.'s 80486 microprocessor in new products. Workstations are rapidly coming down in price, pressuring companies like Compaq that sell high-end personal computers. The success of the Extended Industry Standard Architecture (EISA) bus technology, championed by Compaq and other vendors as an alternative to IBM's Micro Channel Architecture (MCA), is in doubt. And some question whether Compaq's dealer-only strategy can continue as the company sells increasingly complex products.

The company never would have gotten as far as developing and shipping a product without the necessary leadership. "The company has the best management team in the PC business," Shearson Lehman Hutton Inc. analyst Doug van Dorsten unequivocally stated in an August report on Compaq, "and its performance over the last seven years has been of the highest caliber."

The idea of a start-up to develop

Jonathan Levine

and market a portable personal computer was conceived in 1981 by Canion, James M. Harris and William H. Murto, at the time all employed in Texas Instruments' computer and peripherals operations. In one of those humble-beginnings-turned-legend, the three met with an industrial designer in a Houston pie shop to discuss their idea and the designer drew a sketch of the portable on a placemat. (They have held on to the placemat ever since.)

With the rendering, Compaq was able to secure venture funding and the company was on its way. Incorporated in February 1982, the company recorded net income of $4.7 million on sales of $111.2 million in its first full year of operation. Since going public in December 1983, the company has never reported a quarterly loss.

Harris served as vice president of Compaq's Advanced Computer Division, while Murto held the post of vice president for advanced computer marketing. (Today, Harris is senior vice president for engineering; Murto left the company in 1987.) Benjamin M. Rosen, of the Sevin Rosen Management Co., Compaq's major venture capital backer, has held Compaq's chairmanship since its founding.

By the end of 1982, Compaq's senior management team was reinforced by other TI expatriates. Chief among them was Swavely who, before joining Compaq, was head of TI's professional computer marketing efforts. Originally Compaq's vice president

Standards battle: Compaq taking a gamble?

At first glance, Compaq Computer Corp.'s championing of the Extended Industry Standard Architecture (EISA) appears to be a dramatic departure for the usually staid personal computer vendor. Leading an industry insurrection, even against arch rival IBM, seems out of character for the company.

But Compaq president and chief executive Rod Canion argues that it is IBM that has strayed from the path of industry standards with its Micro Channel Architecture. The 32-bit proprietary MCA technology on which IBM based its PS/2 line of microcomputers is the heart of the giant company's effort to beat back the wave of clones that have been eating away at its market share.

In September 1988, Compaq and eight other personal computer vendors, instantly tagged "the Gang of Nine" by observers, proposed developing a new microcomputer bus structure that would remain compatible with the existing standard architecture — commonly known as the ATbus, but dubbed the Industry Standard Architecture, or ISA, by the group because of IBM's copyright on "AT." Hence, Extended ISA, or EISA.

Canion expects sales of EISA-based products to grow slowly, arguing that the powerful technology will only be needed by a small number of the company's customers. Initially the increased input/output offered by the 32-bit bus architecture is needed only for personal computers used as network and file servers. Even manufacturers that plan to unveil microcomputers using EISA expect those products to account for only 5% of their sales for the first year or so.

Canion says that EISA simply establishes a future growth path for manufacturers and users of personal computers using the 16-bit ISA technology. "Nobody needs EISA for their existing products, or their existing applications," he says. "They only need to know that they can have it available to them when they do buy higher performance PCs in the future. Our goal is not to sell as many EISA machines as we can, it's to allow our high-end machines to increase in performance and maintain compatibility."

But industry-watchers are doubtful about EISA's future. IBM has been shipping MCA-based PS/2 microcomputers for two and a half years, while it will be the end of this year at the earliest before the first EISA-based computer leaves the loading dock. "I guess I'm somewhat skeptical of EISA, because there are 2 million MCA machines out there and zero EISA machines," says UBS Securities Inc. vice president Marc G. Schulman. Much depends upon how quickly Intel Corp., which is developing the EISA chipset, can work out the technology's bugs and ramp up volume production.

Meanwhile, cracks are appearing in the EISA stronghold. Tandy Corp. and Ing. C. Olivetti and Co. SpA, among EISA's original backers, have introduced MCA personal computers. So have other industry giants like NCR Corp. (Along with Olivetti, Tandy and Compaq, "Gang of Nine" members include Zenith Data Systems Corp., Hewlett-Packard Co., NEC Information Systems Inc., Epson America Inc., AST Research Inc. and Wyse Technology.)

Despite the gamble, Schulman says that Compaq had no choice but to lead the EISA forces. Compaq depends on being the personal computer technology leader to distinguish itself from its competitors, and adopting the proprietary MCA technology would make that impossible. But Schulman believes that Compaq may either have to swallow its pride and debut an MCA product or concede market share to IBM and MCA clones.

Last July, Compaq and IBM signed a patent cross-licensing agreement covering computer and peripheral technology — including the MCA architecture. But Canion insists that Compaq still has no plans to add MCA to any of its products. The personal computer manufacturer halted all MCA development work more than a year ago.

Ironically, nearly all observers say that neither bus architecture is technologically superior and that politics and marketing muscle will determine the eventual winner. Other analysts argue that the whole MCA/EISA imbroglio is a tempest in a teapot. "The MCA/EISA bus war has all of the excitement of the American invasion of Grenada," wrote The First Boston Corp. analyst Charles R. Wolf in a recent report. ☐

for marketing. Swavely was named president of North American operations earlier this year.

Also coming on board was John F. Gribi, controller of TI's minicomputer operations, who became senior vice president for finance and chief financial officer. He is currently senior vice president for corporate administration and serves as the company's chief troubleshooter. And Gary Stimac, engineering manager at TI, joined Compaq as a systems engineer and is now senior vice president for systems engineering. Stimac's duties include overseeing the company's crucial research and development efforts.

Collective decision making

A key reason for Compaq's prosperity has been its ability to utilize — rather than squander — the talents of its management. Canion, according to Swavely, recognizes the fact that no one has all the answers and so takes a collective approach to decision making.

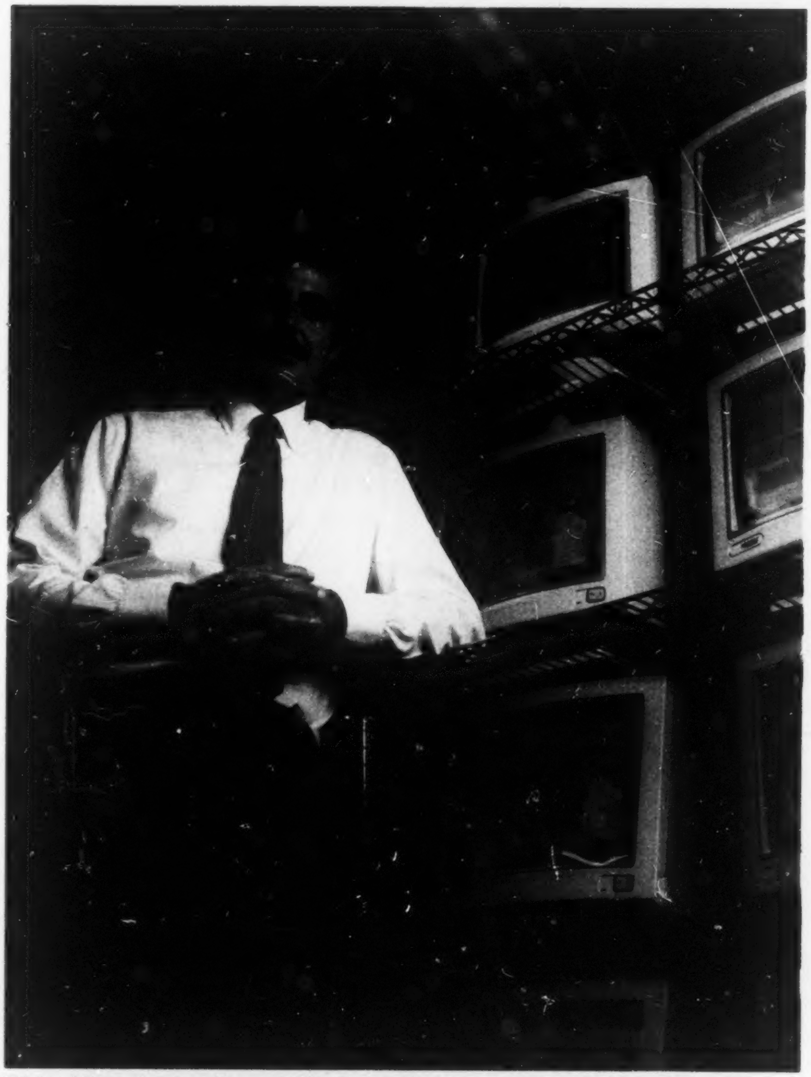
Canion, in turn, says that because Compaq grew rapidly from the start, its management had to take an "almost naive, common sense" approach toward decision making, one that made full use of the management's collective experience.

"We have a team process that leads to getting to the best answer," Canion says. "We've encouraged all the things that it takes to have a team spirit. All companies want it, most of them talk about it, but few companies really have it, at least to the degree to which Compaq has been fortunate enough to develop and maintain it."

Compaq's decision-making process also means that there is less corporate infighting, the chief executive maintains. "My belief is that it is pretty typical, particularly in large companies, to have people fighting with each other to be right. And of course in that environment, a lot of energy is wasted fighting each other rather than your competitors."

Compaq's environment has led to a management stability rarely found in the industry. Nearly all of the senior managers who joined Compaq in its early days are still at the company, a fact that Canion calls "fundamentally critical" to its success.

Early on, Compaq distinguished itself from other vendors by staking out the high end of the personal computer market. Rather than competing on price, Compaq chose to market systems that offered leading edge technology and high performance. Shearson Lehman Hutton calculates that worldwide, the average selling price of Compaq's systems is $3,300, compared with $2,300 for IBM and $2,085 for the personal computer industry overall.



Michael Swavely, president of North American operations: "We've never positioned ourselves based on price. We sell a better product, not a cheaper product"

"We've never positioned ourselves based on price. We sell a better product, not a cheaper product," Swavely says, arguing that selling on price alone does nothing to engender customer loyalty. Compaq's strategy, of course, also allowed the company to command higher prices and profit margins for its products. "We've never been ashamed to ask for more money for our products," he says.

"To be completely accurate, Compaq never saw itself as a clone," Canion says. "We were lumped into this very large group, but we've never come out with a product that was just like IBM's or anybody else's. The only commonality was that we ran the same software and the same peripherals as other systems." He points to the Compaq Portable, the company's first product, as a prime example.

Although Compaq offers desktop

systems based on the older 80286 microprocessor, its bread and butter has been its Deskpro 386 line of 80386-based personal computers ever since the first model was introduced in September 1986. Earlier this month Compaq moved to strengthen that market position by unveiling a laptop weighing only six pounds.

Compaq was a late entrant to the laptop computer market, but the SLT-286, unveiled just one year ago, already generates $350 million to $400 million in sales and accounts for 50% of all laptop sales in the United States, according to Shearson Lehman Hutton.

Compaq uses the same Intel microprocessors and Microsoft Corp. operating systems as do nearly all personal computers, excluding those from Apple. But the company adds value to those standards, designing many of its own components and working closely with manufacturers of others, such as disk drive supplier Conner Peripherals Inc., in which Compaq holds a 40% financial interest.

Compaq is best known for its ability to quickly utilize new technology and ship leading edge products. In September 1986, the company captured the limelight by unveiling the industry's first 80386-based personal computer, beating IBM to the punch by months. Analysts say that strategy allows Compaq to increase cash flow and grab market share before other vendors can follow suit.

"Sooner and better is a pretty powerful combination," concludes Marc G. Schulman, vice president with the UBS Securities Inc. Wall Street firm.

"It's a part of our system and our culture now," Canion says of Compaq's rapid technology cycle. "We can't stay ahead of all the people all of the time, but we can stay ahead of most of the people most of the time, if we keep doing what we've been doing."

Early on, Compaq distinguished itself by staking out the high end of the PC market

Compaq's technology turnaround is remarkable because marketing and sales operations are brought into the design process early on.

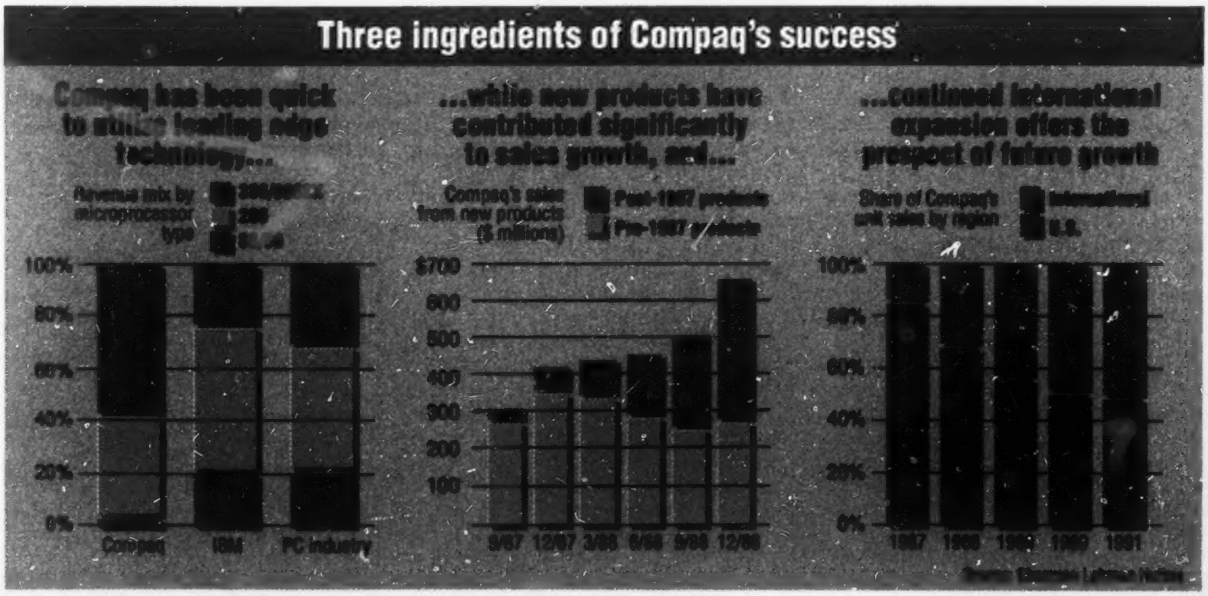
Along with maintaining close relationships with such suppliers as Intel and Conner Peripherals, product marketing director Lorie Strong says that Compaq also "works hard to understand what the market priorities are" and so can better focus its development and marketing efforts. She says that comes from maintaining close contact with end-users despite Compaq's dealer-only sales strategy.

"One of Compaq's key strengths is the degree to which management stays attuned to customers, markets and changes in both," agrees van Dorsten's report. "Good strategic vision and planning, utilizing this market/customer sensitivity, coupled with the best execution in the PC business is what earned Compaq its strong market position."

Users cite a number of reasons for choosing Compaq systems over those from other vendors. Computer Aided Planning Inc., a Grand Rapids, Mich., developer of office planning and furniture specification software, uses its personal computers for publishing, graphics, database and software development chores. Programmer Bill Day cites another reason most of the 40 microcomputers at the company are Compaq: "People walk in the door, they see a Compaq machine, and it presents a strong image to our clients," he says.

Lacking a sales army like IBM's, Canion and company recognized from the start that selling through dealers would be the most effective means of reaching the largest potential market. To avoid channel conflict and instill dealer loyalty, Compaq's management decided that it would distribute its personal computers exclusively through resellers and retail dealers.

Today, Compaq, IBM and Apple are acknowledged to have a firm lock



Source: Shearson Lehman Hutton

on the dealer channel, leaving second- and third-tier vendors to struggle for the little remaining shelf space and settle for narrow profit margins as they try to compete on price.

Cementing Compaq's ties with its dealers is the vendor's generous "soft dollar" dealer support program called Salespaq. Through the program, Compaq offers its resellers credit to finance inventory, personal computers to use for demonstrations and training, and other incentives to push Compaq products.

Split with Businessland

Still, those incentives were not enough to prevent a falling out last February between Compaq and Businessland Inc., the national computer retail chain that accounted for 7% of Compaq's sales. In April, Compaq stopped selling its products through the dealer.

Canion explains that Businessland built up its overhead expenses by emphasizing support and products with added value and yet attempted to compete on price with other dealers. Canion says that required Businessland to seek special discount deals with vendors in order to turn a profit, an idea that the chief executive says would have violated Compaq's policy of treating its dealers equally.

"It was a very difficult decision and a fairly painful process for us," Canion says of the Compaq-Businessland split. Although he acknowledges that the break with the dealer left a gap in the company's sales, he says the hole has since been filled by other resellers.

Nearly half of Compaq's revenue comes from business outside the United States, and much of that — $734 million of the company's $2.06 billion 1988 revenue — comes from Europe. The European personal computer market has been growing at twice the rate of the U.S. market, and Compaq moved to establish a presence on the continent in 1983 by establishing a dealer channel there before most U.S. vendors. By the first quarter of this year, Compaq had snagged 10.2% of the European personal computer market, says UBS Securities, surpassing native vendor Ing. C. Olivetti and Co. SpA to become the second largest microcomputer vendor on the continent behind IBM.

Canion recognizes the fact that Compaq is not in complete control of its own destiny

Compaq owes a great deal of its European success to Eckhard Pfeiffer, who was head of Texas Instrument's European consumer electronics operation when he was recruited in September 1983 to take charge of Compaq's European sales efforts. More recently, he has been named president of international operations.

Desktop and portable personal computers sold in Europe are built at Compaq's assembly plant in Erskine, Scotland, on the outskirts of Glasgow. The company is adding 230,000 square feet to the plant's manufacturing area, bringing its total to 490,000 square feet, to meet demand. And last month, in an illustration of how personal computer vendors are up and minicomputer manufacturers are down, Compaq purchased ailing Wang Laboratories Inc.'s Stirling, Scotland, facility, which has 135,000 square feet of manufacturing space.

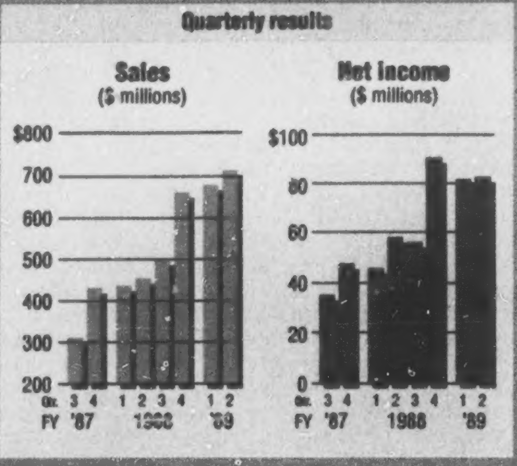
Looking ahead

Analysts' expectations for Compaq's 1989 sales hover around the $3 billion mark, a 46% gain over 1988's $2.06 billion in sales. And Wall Street estimates for fiscal 1990 (ending Dec. 31) fall in the range of $3.8 billion to $3.9 billion, representing growth of some 29%. Overall, Compaq is expected to show yearly sales and earnings growth of 20% to 35% over the next three to five years. Compaq placed ninth on ELECTRONIC BUSINESS' list of fastest-growing companies with a five-year compounded average annual growth rate of 79.4% [ELECTRONIC BUSINESS,

Compaq at a glance

	1988	1987	Change
Sales ($ millions)	$2,066	$1,224	+68.7%
Net income ($ millions)	$255	$136	+87.3%
Net income/ sales	12.4%	11.1%	—
Cost of sales/sales	59.7%	58.6%	—
R&D/sales	3.6%	3.8%	—
Marketing, G&A/sales	19.2%	18.5%	—
Number of employees	6,056	4,109	+47.4%
Sales per employee	$341,077	$297,899	+14.5%
Net income per employee	$42,147	$33,163	+27.1%
Capital expenditures/sales	13.2%	8.5%	—
Current ratio	2.32	1.99	—
Debt/equity ratio	0.34	0.37	—
Foreign sales/sales	38.6%	26.0%	—

All figures for fiscal year ending December 31.



Source: Company reports

May 1, 1989.]

Not surprisingly, Canion is cautious about predicting the future. "Since I could not possibly have imagined being a $3 billion company five years ago, I would hesitate to project any sales," he says. "We concentrate on laying the foundations correctly. If we lay the foundations correctly, then we will grow relative to the opportunities."

Canion and Swavely both believe that as personal computers become more powerful and are used for new applications, understanding and penetrating the new markets opened up by those applications is the major challenge facing Compaq.

"A whole new level of applications will be opening up for our products," Swavely says. He cites growing sales of high-end personal computers for CAD/CAM applications and for use as network servers — markets that have traditionally been the domain of workstations and minicomputers, respectively.

Shearson Lehman Hutton estimates that 40% to 45% of Compaq's 80386-based system sales already go for CAD/CAM and network server applications. That trend will accelerate when Compaq unveils even more powerful computers in the next few months incorporating the EISA technology (see accompanying box) and Intel's next-generation 80486 microprocessor.

Selling microcomputers for use as network servers and workgroup, or multiuser, applications likely represents the biggest change in Compaq's marketing future. In addition to competing more and more with minicomputer and workstation vendors for sales, more complex products could mean increased demands from users for service and support.

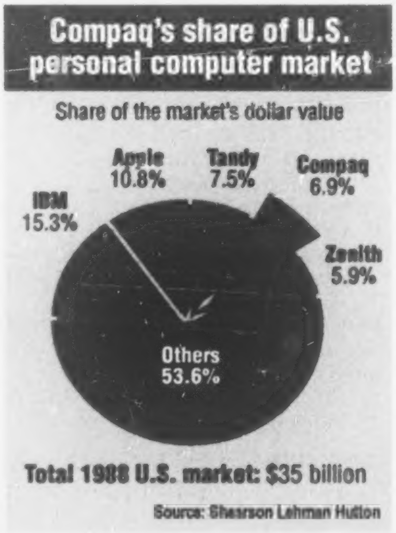
That, in turn, could force Compaq to rethink its dealer-only distribution strategy. Dealers could begin demanding better profit margins and more "soft dollar" incentives to cover increased service and support expenses. Or, Compaq itself may have to develop its own service and support infrastructure.

"The question is, can resellers sell $15,000, $20,000, $40,000 systems?" Kimball Brown, a senior analyst with Prudential-Bache Securities Inc. "Resellers I've talked to are confident they can support [such systems]. We'll see."

Although not ruling out the possibility of other sales channels, Canion says that, to date, the dealer channel has done a good job of keeping pace with technological development and he does not foresee any change soon in Compaq's strategy.

UBS' Schulman believes that personal computer vendors — particularly those like Compaq with products at the high end — will begin to feel the competitive heat from workstations that are rapidly improving in price/performance. In his "Profits, Not Prophets" report, Schulman speculates that Compaq may one day have to adopt the same Reduced Instruction Set Computer (RISC) technology that is driving the workstation market.

Analysts also say that Compaq could face increased competition from IBM. Canion and industry watchers alike dismiss IBM's introduction in mid-June of a 486 add-in board for the PS/2 Model 70-A21 as a preemptive publicity strike. But if IBM unveils a complete 486 PS/2 that matches Compaq's products in performance, or is aggressively priced, Compaq may be in for a fight. "My sense is that, technologically, IBM is becoming more assertive," Schulman says.


Compaq's share of U.S. personal computer market

Share of the market's dollar value

Total 1988 U.S. market: $35 billion

Source: Shearson Lehman Hutton

But Canion says that IBM has been Compaq's main competitor all along, and he expresses confidence that the smaller company will be able to stay ahead. Prudential-Bache's Brown agrees. "Even as a $3 billion company, Canion and a few top managers can sit around and make a major decision in a few hours," according to Canion. "IBM takes 200 signatures to get a product out."

Taking new technology and quickly incorporating it into mainstream products will remain a major challenge for Compaq, according to Murray Francois, senior vice president for corporate quality and materials. "We are the leading edge of technology. So we have to utilize technologies that are immature and unstable."

But Compaq, at times, finds itself dependent on other manufacturers to supply that technology. There have been reports that volume shipments of the 80486 microprocessor and the EISA chipset may not begin on time. Prudential-Bache's Brown says that could have the hardest impact on Compaq, since the company depends on leading edge products to gain and hold market share and maintain profit margins.

"They are not in total control of their future," Brown says of Compaq. And as the company waits for the 80486, other personal computer vendors catch up. Between this year's March and June quarters, Compaq's unit share of the 80386 microcomputer market plunged from 48% to 38%.

Brown, nevertheless, says that Compaq will "undoubtedly" stay ahead in the technology race. He says that even if other vendors announce 80486-based products first, "Compaq will be the first to volume ship, in my view. And volume shipping is what matters."

Canion recognizes the fact that Compaq is not in complete control of its own destiny. He says a goal of the company is to grow and hold a large enough market share "so that we have more of a say about our future direction, which you have much less ability to affect if you are a small player back in the pack."

Canion acknowledges that Compaq could be hurt by an economic slowdown or some other external force beyond its control. But he expresses confidence that, unlike other fast growing computer companies that have imploded, Compaq is on a solid foundation. "I don't believe that the pitfalls Compaq will have to deal with will involve our ability to execute internally," according to Canion. □

The best companies in the electronics industry

For a different perspective on the electronics industry, this year's survey for the Best Company is based on opinions of ELECTRONIC BUSINESS subscribers from both the management and financial communities.

CAPITAL EQUIPMENT

Management community	Financial community
Hewlett-Packard 68.8%	**Hewlett-Packard** 64.3%
Tektronix 8.5%	**Applied Materials** 24.8%
Base: 567	Base: 129

COMMUNICATIONS

Management community	Financial community
AT&T 30.9%	**Andrew** 61.3%
Motorola 26.6%	**M/A-Com** 13.2%
Base: 531	Base: 106

COMPONENTS

Management community	Financial community
AMP 36.5%	**Oak Industries** 47.0%
AVX 18.0%	**Sprague** 27.4%
Base: 512	Base: 117

DISTRIBUTION

Management community	Financial community
Arrow 31.2%	**Avnet** 34.7%
Avnet 24.5%	**Premier Industrial** 17.8%
Base: 486	Base: 101

GOVERNMENT

Management community	Financial community
Texas Instruments 20.9%	**E-Systems** 19.4%
Motorola 19.1%	**Motorola** 18.4%
Base: 498	Base: 103

MAINFRAMES

Management community	Financial community
IBM 56.5%	**IBM** 46.8%
Cray Research 23.7%	**Cray Research** 24.2%
Base: 540	Base: 124

MICROCOMPUTERS

Management community	Financial community
Compaq 37.5%	**Compaq** 54.5%
Apple 29.3%	**Apple** 28.8%
Base: 547	Base: 132

MINICOMPUTERS

Management community	Financial community
DEC 32.8%	**Sun Microsystems** 35.8%
Sun Microsystems 30.3%	**DEC** 25.4%
Base: 548	Base: 134

OFFICE EQUIPMENT

Management community	Financial community
IBM 44.8%	**IBM** 35.5%
Xerox 25.5%	**Pitney Bowes** 29.8%
Base: 525	Base: 121

PERIPHERALS

Management community	Financial community
Seagate 35.5%	**Conner** 33.6%
Conner, Wyse (tie) 10.5%	**Seagate** 29.9%
Base: 487	Base: 107

SEMICONDUCTORS

Management community	Financial community
Intel 32.7%	**Intel** 53.3%
Motorola 20.3%	**Chips & Technologies** 10.7%
Base: 542	Base: 122

SOFTWARE

Management community	Financial community
Microsoft 57.4%	**Microsoft** 43.8%
Lotus 17.6%	**Computer Associates** 21.5%
Base: 535	Base: 121

DIVERSIFIED ELECTRONICS

Management community	Financial community
General Electric 26.2%	**General Electric** 28.2%
3M 19.7%	**3M** 24.8%
Base: 538	Base: 117

High tech steps into an uncertain tax future

An ELECTRONIC BUSINESS survey reveals that while the top electronics industry taxpayers saw their total bills rise only 7% last year, long-term planning will be "virtually impossible"

By BRUCE C.P. RAYNER
and LINDA STALLMANN

Mild respite. That's what top electronics companies got on their 1988 tax bill, according to an exclusive tax survey conducted by ELECTRONIC BUSINESS. One year after the full force of the 1986 tax reform hit corporate America, the electronics industry appears to have survived the worst of the bloodletting. The big question is, what is in store for the tax code in 1990? The answer: uncertainty.

1988 was a pretty good year for the electronics industry as far as taxes are concerned. On average, the companies surveyed saw only a 7% increase in their total tax bills — down from a 27% rise in 1987 tax payments. But taxes as a percentage of sales declined from 4.3% in 1987 to 3.85% in 1988.

ELECTRONIC BUSINESS' survey encompasses 133 publicly held, U.S.-owned electronics and computer companies that derive at least 70% of their sales from electronics.

A drop in tax rates was also a welcome relief for the electronics industry. The effective, or actual, tax rate for 1988 for the companies surveyed fell to 37.3%, down from 39.4% in 1987 and 42.9% in 1986. If IBM were removed from the list, the average effective tax rate in 1988 would be an even lower 36.2%.

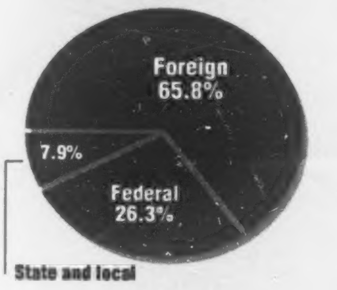
The biggest contribution to lower tax bills came from an unexpected 20.5% decline in federal taxes, measured as a percentage of sales. At the same time, state and local taxes fell by 3.8% in 1988 and foreign taxes held more or less steady, dropping by 1.8%. The magnitude of the federal tax decline is surprising, considering that tax reform was aimed at extracting *more* tax dollars from industry by closing loopholes. This is explained, in part, by generally lower profits coupled with a higher percentage of business coming from overseas.

It is still foreign taxes that account for the greatest share of the electronics industry's taxes. The top electronics money makers saw a rise in the percentage of their taxes that went overseas, from 61.2% of the total in 1987 to 65.8% in 1988.

In all, this year's 133 companies surveyed paid foreign governments nearly $6 billion; that compares with slightly more than $5 billion paid by the 130 companies surveyed last year. The biggest contributor in both years was IBM.

Foreign taxes account for the majority of electronics tax dollars

Percentage of total taxes



Source: ELECTRONIC BUSINESS

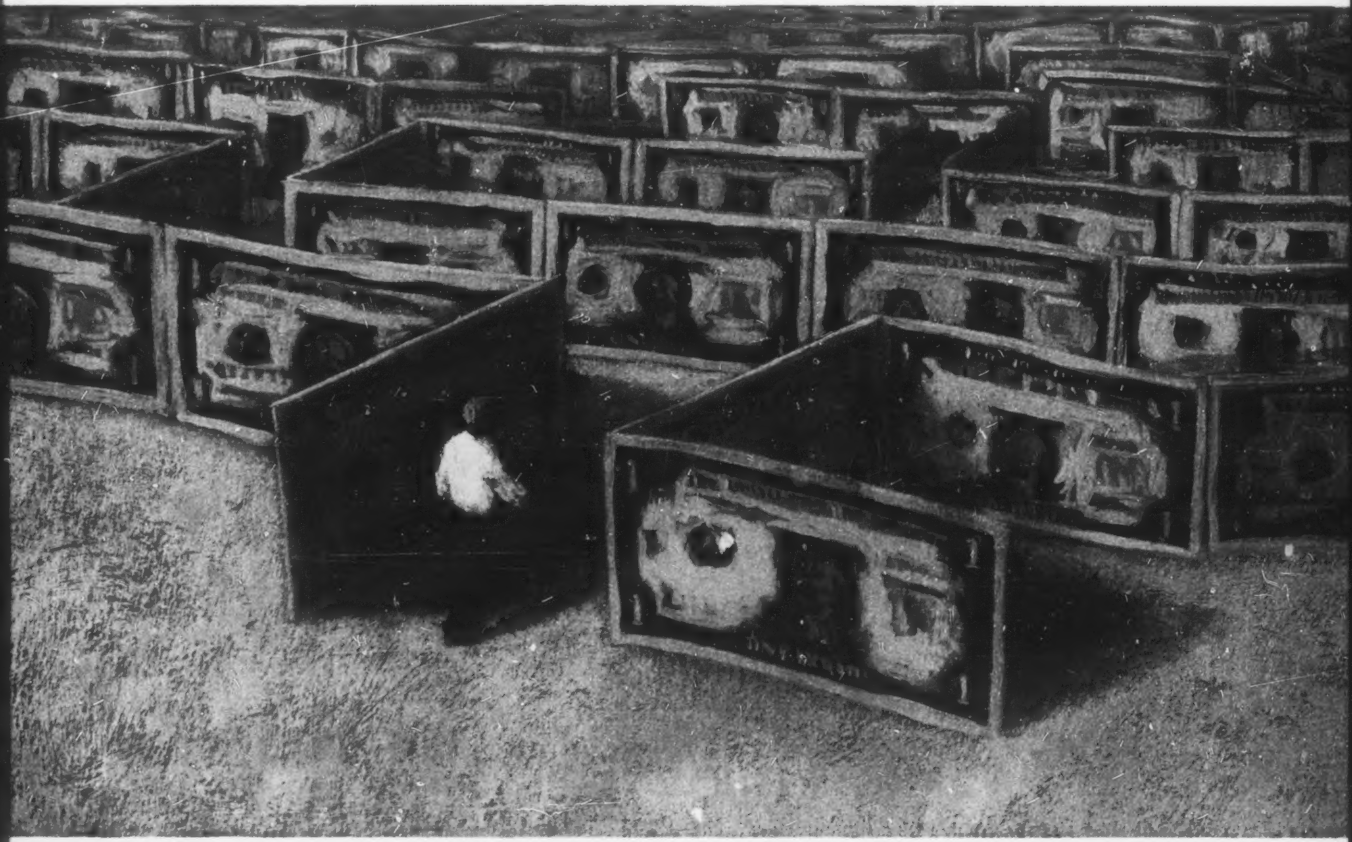
IBM at top of list

It should come as no surprise that IBM sits at the top of the ELECTRONIC BUSINESS taxpayers survey. In 1988, IBM accounted for more than a third of the taxes paid, setting aside $3.649 billion to be redistributed to foreign governments alone. As for domestic taxes, IBM didn't pay any federal income tax last year but, instead, received a tax credit to the tune of $132 million; it shelled out only $25 million for its state taxes.

A total of 18 companies in this year's survey received federal tax credits, totaling $203.26 million. That is up slightly from the 17 companies that got $196.38 million in credits in 1987. Likewise, seven companies received credits on state taxes, up from five in 1987. At the same time, six companies got credits on foreign taxes, compared with two the previous year.

No company comes close to IBM in terms of the sheer size of its tax bill. Indeed, second-placed Xerox Corp. set aside a mere 13% of IBM's bill, or $470 million, for foreign, federal, state and local governments in 1988. Another notable contributor to domestic government coffers was GM Hughes Electronics Corp. It had the biggest federal and state tax bills of those surveyed, totaling $336.4 million.

But what of the future? How will IBM, Xerox, GM Hughes and all of the other high-tech taxpayers fare in



the coming decade?

In general, the stream of tax reform that has been spewing out of Washington since the early 1980s is ongoing. As with any change of that magnitude, the biggest effect it has had is to increase uncertainty, tax experts say.

According to Coopers & Lybrand, a major international accounting firm, tax law changes since 1980 have made long-term tax planning "virtually impossible." When to buy assets, when to sell, when to allocate income and when to defer it all have been complicated because tax rules and rates are changing and will continue to do so.

Key advice of many accountants as the end of 1989 approaches is to declare income this year as opposed to deferring it. The rationale: Tax rates will only go up in the future. But just when and by how much, no one is willing to guess.

Adding to the uncertainty is the increase in complexity in the tax code. The most notable example is the alternative minimum tax (AMT), which all companies are required to calculate. Basically, the AMT means companies have to keep another set of records on top of the accounts they already keep for financial and tax purposes, adding to their load of paperwork.

The AMT calculation is having a particularly severe effect on small start-ups, especially in Silicon Valley, says Dennis Armstrong, a tax partner at Coopers & Lybrand in San Jose. These companies are finding they have to pay federal income tax based on the AMT calculations, even though they typically have net operating loss carry-forwards, Armstrong says. The alternative minimum tax regulations state that only 90% of the net operating loss carry-forwards can be sheltered. "That comes as a big surprise to many companies," says Armstrong.

A positive trend of the last few years is the relative lowering of the U.S. tax rate in relation to its trading partners

While the AMT stands out as a particularly gruesome example of complexity, it is not the exception to the rule. Instead, complexity, not simplicity, has been the result of the last round of reform. It is everywhere, most notably in international tax issues like the transfer of technology overseas — the "super royalty" provision — and is even spilling over into the individual states' tax codes.

The states are starting to be more aggressive in their tax policies which are driven by their own budgetary problems. Just dealing with the myriad state tax codes is more time consuming than dealing with the complexity of the AMT, says Robert Perlman, vice president for tax, customs and licensing at Intel Corp.

The biggest tax event this year is the impending legislation in Congress. It has its origins in the budget deficit and the need to raise at least $8 billion in additional revenue in fiscal year 1990 without introducing an out-and-out tax increase. Through last month, the bill had yet to be made into law.

Even with the threat of higher taxes, there nonetheless are some enticing tidbits for business. Of major benefit to the high-tech community is the proposal to make the research and experimentation tax credit permanent. The credit is scheduled to expire by the end of the year [ELECTRONIC BUSINESS, July 10, 1989]. One negative point in the legislation principally will affect defense electronics firms: a proposal to eliminate the completed contracts method of accounting and replace it with a 100% installment-based method. The disadvantage is that companies would pay tax on income they have not yet received.

Capital gains controversy

But most controversial is the lowering of the capital gains tax rate, a pet project of President Bush. Even House Ways and Means Committee Chairman Dan Rostenkowski (D-Ill.) appears to be in favor of reinstating the differential. However, as with all other tax issues this decade, the capital gains tax calculation will prove to be another nightmare in complexity, accountants say.

Adding to the complexity are the shenanigans of the Federal Accounting Standards Board (FASB). The board has fueled the fire by introducing Rule 96 and then postponing its required implementation date twice. The new rule is a balance sheet approach for reporting deferred taxes so they take into account all current and subsequent changes in tax rates. It is now set to go into effect at the end of 1990, but some companies have already implemented the changes and are floundering now because of lack of direction from FASB.

Look who got a tax credit from Uncle Sam

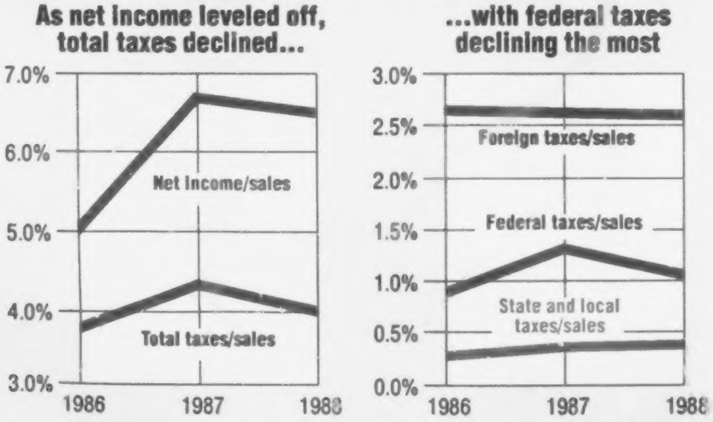
1988 federal tax credits ($ millions)

IBM	$132.00
Cullinet Software	18.92
Augat	10.72
Emerson Radio	7.81
Prime Computer	7.03
QMS	5.13
Storage Technolgy	4.50
Quantum	4.21
Perkin-Elmer	2.40
Oak Industries	2.19
Genicom	2.13
Apollo Computer	1.79
Tandon	1.39
Micropolis	1.10
BRintec	0.60
SCI Systems	0.54
Audiovox	0.44
General DataComm	0.38

Source: ELECTRONIC BUSINESS

Federal taxes take a smaller bite

Figures are as a percentage of sales



Source: ELECTRONIC BUSINESS

On the bright side, a positive trend of the last few years is the relative lowering of the U.S. tax rate in relation to its trading partners. This has turned the United States into a sort of tax haven, some accountants argue, with foreign capital flooding into the country to escape higher rates overseas. At the very least, others say, plant and office location decisions are being made on an economic rather than a tax basis.

As a result, some of these trading partners are now starting to lower their own rates. For instance, Denmark has lowered its tax rate from 50% to 35%, and France dropped its rate from 50% to 42%. Even Japan has been through its own brand of tax reform and lowered its corporate tax rates. Ironically, the effective tax rate for foreign firms with subsidiaries in-country is now slightly higher than it used to be, says Intel's Perlman.

Because of the increase in foreign capital in the United States, there is a paranoia on Capitol Hill that foreigners will take over the U.S. economy. The idea is to discourage such investment. There is a provision in the 1989 tax bill that would limit interest deductions by foreign shareholders that own parts of U.S. companies.

"That could have an impact on high technology because of retaliation" by foreign governments, says Sridar Iyengar, a tax partner in the international and high technology group of KPMG Peat Marwick in San Francisco, a major international accounting firm. "My concern is that if we go too far in taxing inbound investment, then there may be some backlash on the outbound investment," he says.

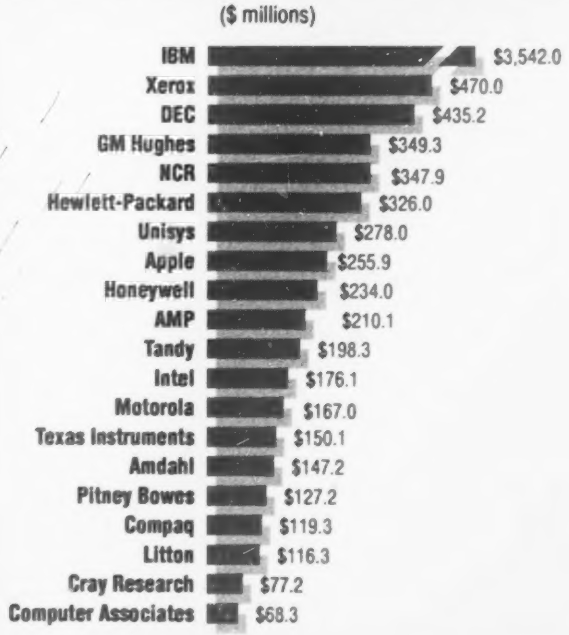
Iyengar also worries about the tax consequences for U.S. electronics companies when the trade barriers come down in Europe at the end of 1992. The Europeans are considering making European content a requirement for sale in their market. That has implications for auditing and introduces complexities if U.S. companies are forced to open European subsidiaries, he says. For instance, the European Community may require the diffusion process in semiconductors to be performed in Europe if product is to be sold there.

At the same time, U.S. companies may decide that they don't need multiple subsidiaries serving the EC and can run operations from one central office that covers the entire continent. If that is the case, there are certain negative U.S. tax rules affecting subsidiaries that operate outside of the country of incorporation, says Iyengar. □

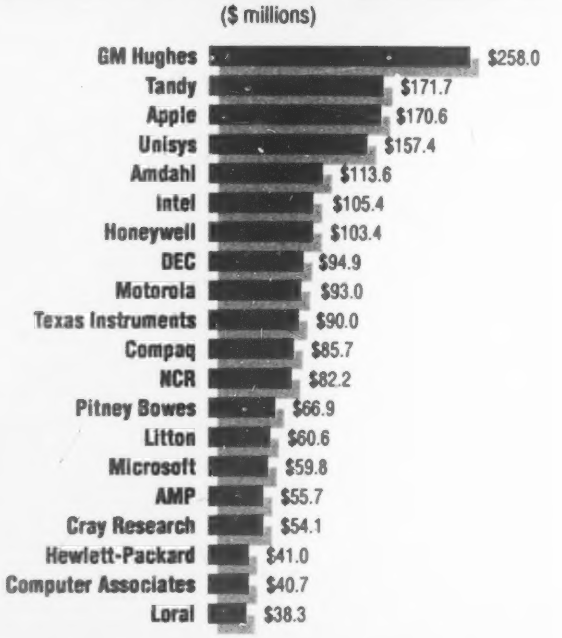
Related tax charts appear on next page

Top 20 electronics industry taxpayers — 1988

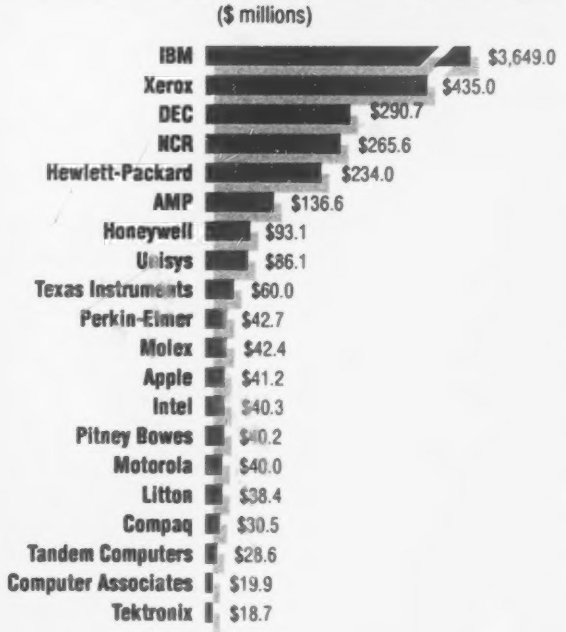
Total taxes



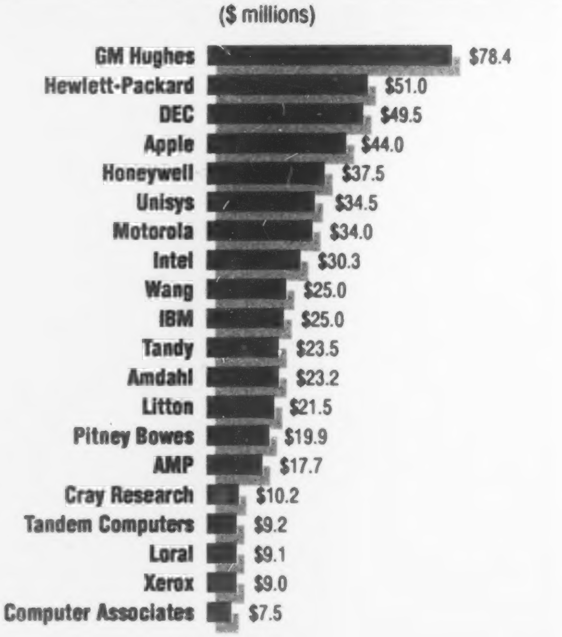
Federal taxes



Foreign taxes



State and local taxes



Source: ELECTRONIC BUSINESS

National distributors tighten their belts

Market softness is forcing U.S. electronics distributors to operate leaner and work on building better profits — which industry observers say is long overdue

BY JOHN McCREADIE

Being caught between a rock and a hard place is nothing new to electronics industrial distributors. After all, it is the nature of the business for any "middle man" sometimes to get squeezed between customers on one end and suppliers on the other. But for electronics distributors today, the squeeze is getting tighter.

Now, more than ever, distributors are being crunched between component makers pushing for bigger volumes of sales and customers demanding more value-added services.

"They walk a very fine line when it comes to dealing with both suppliers and customers," says Karen Payne, technology analyst for the brokerage house Wheat First Butcher & Singer of Richmond, Va.

Coming off a three-year period of brisk sales — averaging 17% annual growth — distributors are repositioning themselves, in the face of dismal industry forecasts, to weather some tough times.

The industry is undergoing "a mild recession," as one analyst calls it. With 1987 shipments totaling $7.3 billion, annual growth from 1987 to 1988 hit a booming 24%, according to the National Electronic Distributors Association (NEDA). But results in the first half of this year have been disappointing, and few observers expect the sector to edge significantly past the 1988 mark of $9 billion. Analyst projections for 1989 range from a 2% decrease to a highly optimistic growth of 10%.

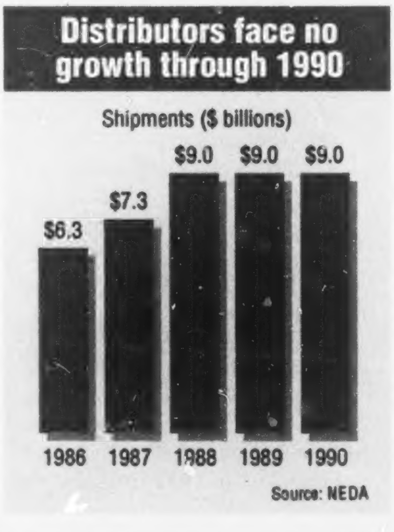
And with uncertainties about a recession clouding the nation's economic future, the 1990 outlook for distribution is not much better. "We see only a 2% decrease to no growth for 1989, while 1990 is forecast at basically the same flatness, no growth to 2% growth," according to NEDA in a recent newsletter.

Says Joe Semmer, president of Hall-Mark Electronics Corp., "We're looking to flat industry growth in the third and fourth quarters [of calendar 1989] and 1990 being up between no growth and 5%" — echoing expectations of several industry executives.

In response to these tightening market conditions, such major distributors as Avnet Inc., Wyle Laboratories, Marshall Industries and Anthem Electronics, indeed, are changing the way they do business.

Distributors are shifting their focus from simply striving to increase sales to taking a much harder look at the profitability of the lines they carry — even if it results in friction with their key suppliers. Many semiconductor companies increasingly are realizing they do need strong distribution networks; some, such as Motorola Inc., are actually lowering their distributor pricing schedules on selected items.

With this profits review comes increased scrutiny of longtime, standard distribution programs such as ship-from-stock-and-debit. The complicated inventory and pricing scheme originally was intended to protect distributors from fluctuations in the market. But because of the cash the plan ties up, the method has been a drag on profits for years.


Distributors face no growth through 1990

Source: NEDA

Long-term prospects

The industry's longer term prospects are reassuring, assuming there is no economic recession, according to analyst Clarke L. Walser, senior vice president for The Chicago Corp., an investment firm in Chicago. "Distribution sales should start showing year-to-year improvements," he says.

With few exceptions, manufacturers that have tried going it alone on distribution have found themselves in over their heads in a tough end of the electronics business. And, as the technology grows more complicated, customers are finding themselves relying more and more on the services distributors add, such as field application engineering.

"As product complexity grows, distribution becomes integral to the execution of our business," concurs Skip Streber, distribution manager for Texas Instruments Inc.'s Semiconductor Group.

Despite a profits crunch, "distributors now account for nearly 30% of the total sales of components in the United States, compared with less than 20% a decade ago," says analyst Walser, noting that the top 25 companies account for more than 85% of industry sales.

The industry's biggest blemish today is its five-year downtrend in gross margins. Walser notes gross margins have fallen 3% from an industry peak of 25.9% in 1984 to a subsequent high of 22.9% in 1988. Current estimates put industry margins about 23%. By comparison, net after-tax margins have fallen from 4.0% to 2.7% during the same time period, Walser says. Net margins had fallen even further to 2.0% in the first half of this year, he says.

Wall Street, already with a dim view of high-tech companies, is concerned about the falling margins. Anthem president Peyton L. Gannaway points out: "Ultimately the lack of adequate sustained profits is what causes investor disinterest and the inability to raise the necessary debt or equity financing. And the resulting lack of cash is what causes a distributor to restructure or liquidate."

"Bolt to a billion"

One distributor that typifies the problem of focusing too much on the top line is Arrow Electronics Inc. of Melville, N.Y. Even though the company fulfilled its "bolt to a billion" goal last year with its acquisition of Kierulff Electronics, nearly doubling its sales to $1 billion, the success was of little comfort to shareholders, who watched profits plummet.

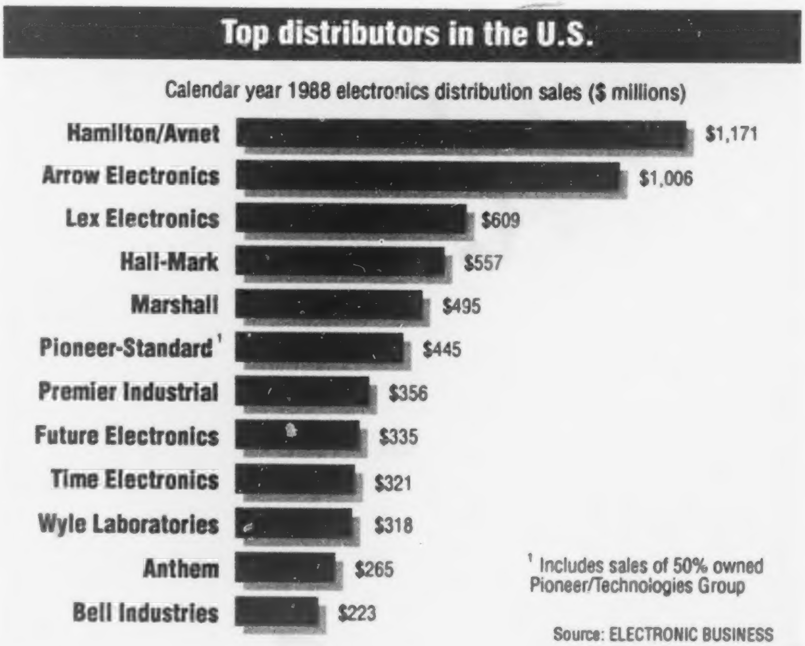
Financial analysts view Arrow's high level of debt as "crippling." According Analyst Richard C. Billy for Prudential-Bache Capital Funding, Arrow's quarterly break-even point is still $230 million, although that is down from $250 million 12 months ago. So Arrow is highly dependent on increasing quarterly sales "as a result of its very high degree of financial leverage," due in part to the Kierulff deal completed in late 1987.

"Arrow is the perfect example of how not to run a distribution business," says one industry executive who voiced an opinion shared by a few executives in the industry.

But Arrow president and chief executive Stephen P. Kaufman resents such a bleak portrayal of his company. "Our overall company gross margins are at 22%," Kaufman states flatly. "We're not a price seller."

According to analyst Payne, the shrinking margins may have bottomed out. "The financial conditions of the industry's price leaders — Arrow in particular — will simply not allow further margin erosion."

An aggressive restructuring at the industry leader, Avnet Inc., led by new chairman and chief executive Leon Machiz, is aimed at improving the bottom line and may be a key indicator that industry margins may have peaked. According to Payne, "The new emphasis on profitability at the largest and most visible electronics distributor, Avnet, is likely to have positive repercussions throughout the industry."


Top distributors in the U.S.

Calendar year 1988 electronics distribution sales ($ millions)

[1] Includes sales of 50% owned Pioneer/Technologies Group

Source: ELECTRONIC BUSINESS

Raves for Anthem

One successful distributor, Anthem, has financial analysts applauding its ability to maintain strong margins despite contracting demand. "Anthem is the best managed and most profitable distributor in the industry," raves Payne. Keeping focused on semiconductors and computer systems and carrying only 25 product lines, compared with the more than 100 lines typical of competitors, the San Jose-based distributor ended calendar 1988 with a net income of nearly $12 million on revenue of $265 million. Gross margin averaged 22.8%.

As other distributors follow Anthem's lead, most are wrestling with ways to bring profits up. "We're expensing ourselves out of business," says Hall-Mark's Semmer.

One of their biggest expenses is ship-from-stock-and-debit programs. Often criticized for their labor-intensive paperwork and endless inventory adjustments, ship-and-debit programs protect distributors from falling market prices. In theory, these price-protection clauses in franchise agreements sound great for distributors. The schemes allow them to recover, through debits, the difference between book costs and typically lower actual market prices.

The result of all this, distributors complain, is a pricing policy that shifts the cost of maintaining inventory from the manufacturer to them. "This is not a trivial matter," according to Walser. "We estimate as much as 20% of the industry's stated inventory today represents overpricing." Walser says it amounts to a "phantom inventory" and reduces the industry's gross margin by as much as a full percentage point.

One way distributors are eliminating debit-related paperwork, however, is with Electronic Data Interchange (EDI) computer systems. But the cost of implementing and expanding on such systems is high. Bell Industries Inc.'s chairman and chief executive Theodore E. Williams reports investing more than $30 million in hardware and software in its EDI system over the past five years.

Aside from improving EDI systems, distributors and suppliers are working together to cut the cost of ship-and-debit programs in other ways. Several suppliers, notably Harris Corp.'s Semiconductor Products Division, are creating programs to estimate quarterly debit expenditures and compensate distributors up front. "We only give ourselves credit after distributors ship to their customers," says George L. Gadzinski, Harris' director for national sales. This helps to eliminate tying up distributor revenue, says Gadzinski, and lessens the impact of "phantom" inventories.

That help is significant, since 60% to 70% of distribution transactions have a ship-and-debit attached, according to Gadzinski. And because the cost of handling a debit transaction is between $25 and $30, many suppliers are limiting the ship-and-debit programs to high volume, short-term sales.

Still other distributors are waiving ship-and-debit protection on selected products. For instance, Avnet's Machiz is turning risk-taking into profits. Buying selected products such as standard logic chips or other mature products at current market prices, Machiz gets units at a lower cost and bypasses many of the ship-and-debit costs. As a result, Avnet pulls more to its bottom line.

Using fewer distributors

Some distributors, meanwhile, are seeing suppliers tighten their distribution channels. This helps the distributor by limiting line competition. Advanced Micro Devices Inc., following its merger with Monolithic Memories Inc. in 1987, had 18 distributors in the United States. Today the company has just six domestically. And the Santa Clara, California-based chip maker is keeping an eye on how to reduce its distribution base further, says Al Frugaletti, director of sales and domestic distribution. "Ideally, all you need is four [distributors] in big cities and three in small ones," Frugaletti says.

Although not all suppliers are streamlining distribution channels, those that do are being applauded by distributors. "Harris has cut their distribution in half [in early 1989]," says Semmer of Hall-Mark. "That's a significant and bold move."

Passive component maker Sprague Technologies Inc. of Stamford, Conn., is another supplier praised for tightening its distribution channels. Five years ago, Sprague had 1,500 distribution channels; today that figure is 23. "We did the terminations by design to work more closely with our distributors," says Lyle Pirnie, vice president for distribution.

Even though "partnering" has become more than just a buzzword for both distributors and suppliers, conflicting ideas about strategy still exist. Installing more field application engineers (FAEs) is a prime example. "I'm pushing them to be more technical," says Jack Browne, director for marketing of Motorola's microprocessor products.

Indeed, as chip and microprocessor designs become more complex, manufacturers, including Intel Corp. and National Semiconductor Corp., want distributors to employ more technical expertise to sell their products. But adding more FAEs is not cheap. Industry executives put that cost close to $100,000 per engineer, including benefit packages.

To further exacerbate the situation, suppliers are feuding over who gets the best engineering representation. Motorola, says Browne, wants to be "on a level playing field" with Intel, accusing the Santa Clara-based chip maker of brute-forcing distributors into employing FAEs without concern for distribution profits.

The distribution industry's biggest blemish today is its five-year downtrend in gross margins

But Intel denies such accusations. "No manufacturer should expect a distributor to do anything for free," says Dennis C. Reker, worldwide distributor marketing manager. Intel claims to be one of the first to offer distribution incentives in an effort to garner more technical representation.

In its effort get better representation, Motorola is implementing its "Blue Chip Program." Essentially, the incentive program will give participating distributors an opportunity to buy selected blue chip products at less cost in return for giving Motorola "parity" technical field support with its competitors, says Browne.

And since distributors will then have more technical expertise, Motorola will send some of its manufacturer-direct customers into the distribution channel, boosting both sales and profits for distributors.

But shifting manufacturers' direct customers to distributors is nothing more than "hype," says National Semiconductor's Keith Kolerus, vice president and director of its distribution unit. "Most manufacturers are trying to move customers to distribution channels because customers are requiring more service, not as an FAE incentive."

FAE alternative

Distributors themselves are seeking cost effective ways to give manufacturers the technical representation they desire. Many are avoiding the tremendous investment in technical personnel by better training their current field representatives.

The sales staff at Anthem, for example, just recently completed a vigorous six-month technical training program on semiconductors and computer systems. Those who passed the final test are now "Anthem Certified," says chairman and chief executive Robert S. Throop, a position that not only garners respect, but also more sales commission.

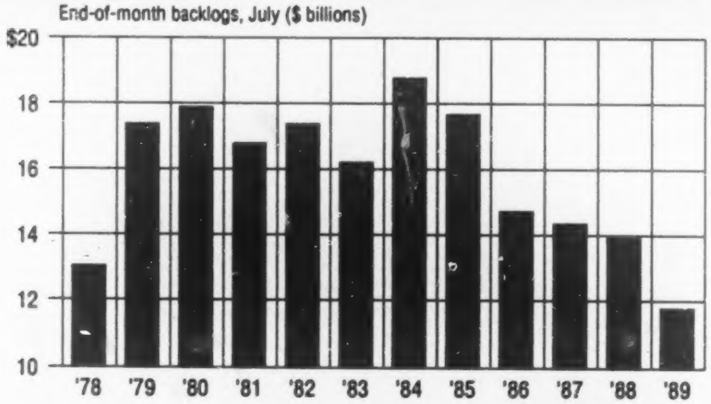
Wyle Laboratories, despite industry-wide criticism over the profitability of entering the high-investment world of application specific integrated circuits design, plans to open a seventh ASIC design center in Boston next year. Another one is nearing completion in Dallas. Ralph L. Ozorkiewicz, president of Wyle's Electronics Marketing Group, estimates that an investment of $1.5 million is required to set up the ASIC facilities. Still, that cost does not include technicians and engineers, the largest part of such an investment, industry executives contend.

Avnet's Machiz says his company's dedication to the ASIC market will "stay where it is now." Approaching the market with caution, Machiz adds that increased efforts there will only occur if "the profitability justifies additional investment."

Meanwhile, as flat sales growth pushes distributors to be more efficient and profit driven, several analysts and executives view industry change as extremely positive, if not a bit tardy. Says Sprague's Pirnie: "Cutting needless expenses is long overdue for distributors." ☐

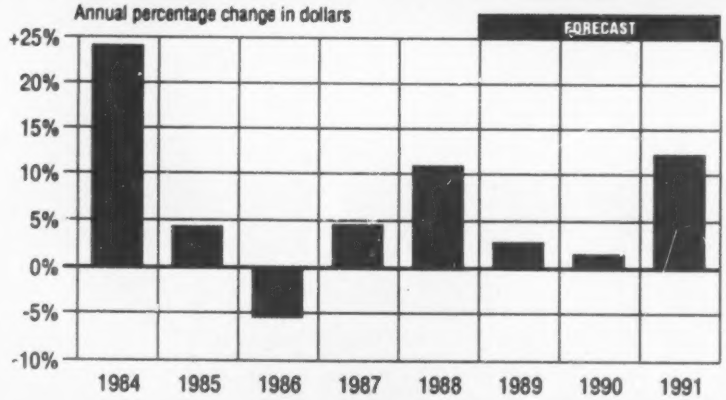
A related story appears on the next page

Shrinking computer backlogs



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Growth in computer shipments shrinks



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Computer backlogs shrink to historic lows

The computer and office equipment manufacturers really took it on the chin. New orders for their equipment sagged 3.2% from June to July and took a whopping drop of 8.2% from July of last year. Shipments, which had been relatively strong despite waning growth in new orders over the last year, were curtailed sharply as well. From June to July, shipments fell 7%, or a decline of 0.3% from July 1988.

The computer industry may be getting into a real bind should the economic contraction go deeper or run longer than currently expected. According to U.S. Commerce Department data, billings for the industry have been outpacing bookings since 1984. That means backlogs have been dwindling.

As of the end of July, unfilled orders for the computer industry amounted to $11.8 billion. That value is the lowest since April 1978 and represents only two times monthly shipments at their current level.

This means the computer and office equipment makers don't enjoy a large buffer to keep production humming as they wait for growth in new orders to turn upward once again. By the end of July, employment in the computer manufacturing sector averaged 477,900, about the same as the figure in July of last year.

MADELINE FRANCHI

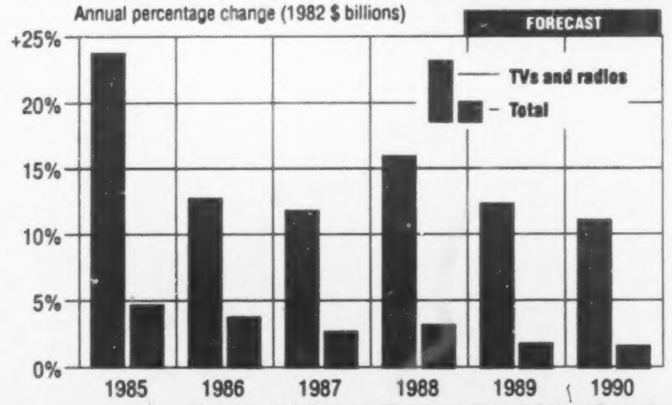
Computer market database

Latest quarter: 2nd quarter 1989	Latest quarter	Previous quarter	Change	Year ago	Change	Next year	Change
Industrial production (SA,1977=100, qtr. average)	350.32	338.67	+3.44	314.97	+11.22%	350.46	+0.04%
Shipments (SA, $ millions, qtr. total)	$17,865	$16,840	+6.09%	$17,290	+3.33%	$17,376	-2.73%
New orders (SA, $ millions, qtr. total)	$16,870	$16,570	+1.81%	$17,381	-2.94%	$16,592	-1.65%
Unfilled orders (SA, $ millions, qtr. total)	$12,206	$13,201	-7.54%	$13,820	-11.68%	$11,914	-2.39%
Inventory-to-shipment ratio (SA, end of qtr.)	1.94	2.07	—	1.91	—	2.05	—
All employees (thousands, end of qtr.)	476.9	474.8	+0.44%	474.9	+0.42%	464.6	-2.58%
Production workers (thousands, end of qtr.)	155.0	155.2	-0.13%	155.7	-0.45%	148.0	-4.53%
Business purchases (current $ billions)	$15.42	$14.70	+4.90%	$15.00	+2.80%	$15.76	+2.20%
Business purchases (1982 $ billions)	$42.02	$39.52	+6.33%	$39.30	+6.92%	$43.78	+4.19%

SA = seasonally adjusted; all other data is not seasonally adjusted

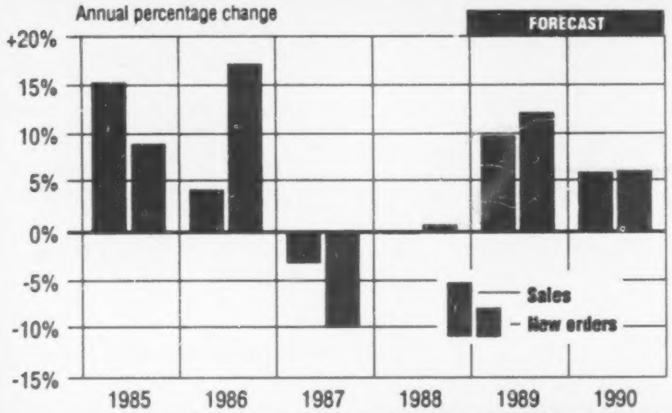
Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

Consumer electronics spending



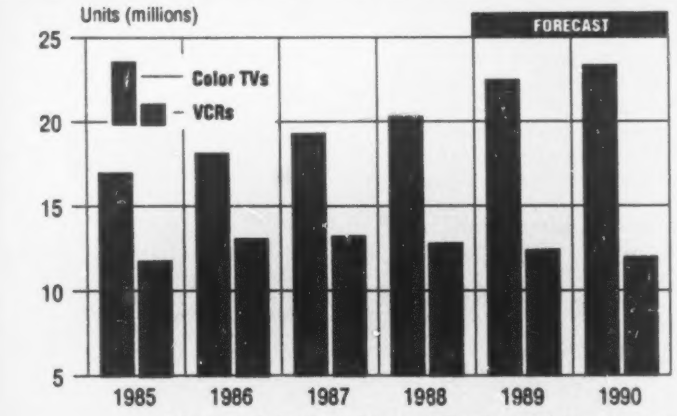
Data source: U.S. Commerce Department; Forecast: Cahners Economics

Growth in TV and radio sales and new orders



Data source: U.S. Commerce Department; Forecast: Cahners Economics

Color TV and VCR sales to dealers



Data source: Electronic Industries Association; Forecast: Cahners Economics

Consumer electronics growth bucks the trend

Consumer electronics growth continues to buck the slowdown trend this year. Personal consumption expenditures for TV and radio equipment totaled $71.5 billion during the second quarter of 1989, a 14.3% gain from the same quarter a year earlier. Spending growth for consumer electronics continues to outrace total personal consumption, which increased only 2.6% in the second quarter above year-ago levels. Cahners Economics expects spending on television and radio equipment to rise 12.5% in 1989 and 11.3% at year-end 1990.

One reason that consumption of consumer electronics has increased over the year is higher interest rates and the anticipation of lower rates in the future. Many consumers cut back on their spending for big-ticket items such as automobiles and homes, buying less expensive items like TVs, VCRs and other electronics products instead. While other electronics industries are experiencing weaker sales growth this year, the consumer electronics industry continues to hold its own.

The U.S. Commerce Department reported that new orders for TV and radio equipment totaled nearly $3 billion at the end of the second quarter compared with the same quarter a year ago, and continued to expand 8.5% from June to July. Meanwhile, shipments slipped 2.1% from June to July, totaling just over $1 billion. Despite this small decline, July sales still remained 14.4% above year-ago levels. Cahners Economics forecasts orders to increase 12% in 1989 and 6.3% in 1990, while sales are expected to grow 9.9% in 1989 and a milder 6% in 1990.

According to the Electronic Industries Association, sales of color TVs to dealers were up 12.7% in August from a very slow month of sales in July. During the month of August, 1.56 million color TVs were sold, on par with sales from a year ago. Cahners Economics expects color TV sales to increase 11.5% in 1989 and only 2.8% in 1990. Nearly 773,000 VCRs and 156,000 camcorders were sold to dealers during the month of August, up 8.5% from last year. The steady sale of VCRs and camcorders has acted as a synergy for TV sales. Many consumers who have purchased new video equipment for their homes have also invested in a new TV.

With the continued introduction of new audio/video products and the relatively low price for a new television set, sales will remain steady. After declines in 1987 and no growth in 1988, consumer electronics sales will grow more than 5% in 1989 and 1990.

MADELINE FRANCHI